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MECHANIZED RESIDENTIAL SOLID WASTE COLLECTION

Marc G. Stragier

Scottsdale Department of Public Works

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This study of automation tested four different types of solid waste collection equipment. Employed were trucks with telescoping arms to pick up single family or multi-family plastic containers. The trucks could also be equipped with a yoke lift for dumping wheeled containers. Close and convenient transfer operations were made possible by use of a truck-to-trailer transfer method. Mechanization showed signifigant cost reductions, increased collection efficiency, improved city appearance, and better, safer working condittions for the collectors.

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MECHANIZED RESIDENTIAL SOLID WASTE COLLECTION

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MARC G. STRAGIER
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1974

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The development of the mechanized vehicles examined in this report required the energies and ideas of many people. Hours of hard work with the experimental vehicles and all those associated with the project made the demonstration a success. The Office of Solid Waste Management Programs, Environmental Protection Agency, is acknowledged for providing the financial support and general guidance needed for an experiment in mechanization of this size.

Equipment manufacturers such as George Morrison, formerly with Western Body and Hoist Company of Los Angeles, container producers such as Reuter, Incorporated, Hopkins, Minnesota; County Plastics, Long Island; and Fusion Rubbermaid, Phoenix; and inventors such as Earl Elton and Howard Smith of Covina, California; public officials such as Fred Glendenning, Deputy City Manager, Phoenix, Arizona and many others have contributed substantially to this project.

Special acknowledgment goes to all the employees of the City of Scottsdale Refuse and Equipment Maintenance Divisions who have accomplished the difficult task of implementing a totally new kind of collection system.

Finally, the Scottsdale City Council and City Manager Dale Carter are acknowledged, for without their complete support and encouragement this demonstration would not have been possible.

--- M. G. Stragier
Director of Public Works
City of Scottsdale, Arizona

MECHANIZED RESIDENTIAL SOLID WASTE COLLECTION

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MECHANIZED RESIDENTIAL SOLID WASTE COLLECTION

SUMMARY

Scottsdale, Arizona has developed a breakthrough in residential single family refuse collection with the assistance of the Office of Solid Waste Management Programs, U. S. Environmental Protection Agency. Using a new family of mechanized vehicles, this demonstration project has shown that twice-per-week refuse collection service can be provided to residents for less than one half the cost of conventional rear end loader systems.

The mechanized service proved to have many advantages. Cost of collection was significantly reduced, while the appearance of streets and alleys was improved. The system includes provision by the City and/or developer of durable and attractive polyethylene containers backed up by a ten year manufacturer's guarantee. Collectors work in air-conditioned cabs and receive higher pay than manual collection drivers and swampers. The safety record during the demonstration was impressive. Working in an industry with the highest 1972 injury rate the mechanized drivers have had no disabling injuries.

The concept that brought about these results is automation. The mechanized arm and the hydraulic ram does the dumping and transferring. The driver of the collection vehicle never leaves the cab during collection, yet he can serve homes more economically and efficiently than a crew of three men who must work extremely hard.

The family of mechanized equipment was made up of four collection systems. The workhorse of the family was a collection vehicle named the Barrel Snatcher. The Barrel Snatcher collects 300 gallon containers located in the alley at a rate averaging 271 dwelling units per hour of collection. The vehicle is a 35 cubic yard packer body with a telephone booth type cab beside the engine. A sturdy 8-foot arm attaches to the chassis beside the engine and telescopes out to grasp containers up to 12 feet from the truck. Containers are engaged, dumped overhead into the body, and replaced by one driver sitting in the cab.

The second member of the mechanized family is called the Litter Pig. The Litter Pig is basically a Shu Pak side loading packer equipped with a telescoping arm loader. The telescoping arm unit bolts to the chassis adjacent to the loading hopper. Without leaving the cab, the single operator can position the barrel gripping hand to engage a container located anywhere in a 30 square foot reach area. The hand can be manipulated by controls from the cab and reaches out and grasps 80 gallon polyethylene containers placed at curbside. The container is mechanically emptied into the hopper and replaced at the curb.

The simplest member of the mechanized family was the yoke lift kit designed for use on a rear end loader. The kit was simply a yoke designed to lift and empty a wheeled container. The refuse collector rolls the container to the lift device, engages the lifting yoke, activates a control that raises, empties and lowers the container, and returns the container to the curb.

As Scottsdale's collection system became more efficient a need for a solution to the haul problem became apparent. The cost of haul becomes particularly critical with mechanized collection systems that collect and fill the vehicles rapidly. A truck loaded conventionally may haul two 20-yard loads per day. By contrast, Scottsdale's alley service collects as many as six 30-yard loads. With a haul of 40 minutes, the collection vehicle spends half its work day hauling. To minimize haul costs a portable transfer trailer system named the Trash Hog was developed. The Trash Hog is a specially designed semi-trailer equipped to transfer from truck to trailer through a simple tailgate assembly. Transfer trailers can be placed close to the collection routes and significantly reduce the haul time for collection vehicles. Each Trash Hog trailer has a capacity of approximately 1200 homes per load. Haul savings accrue through the use of the Trash Hog when the haul time for disposal exceeds 30 minutes round trip.

The interest expressed by Scottsdale residents, other municipalities, private corporations, prefessional organizations and even foreign governments during the demonstration was astonishing. Opinion samples indicated that over 75% of Scottsdale's residents preferred a mechanized collection system. Written inquiries or personal visits came from interested individuals and organizations in France, Australia, Belgium, Canada, Scotland, Norway, Japan and throughout the United States.

We hope that the time and effort spent in answering inquiries and in showing the system to visitors have helped to publicize the need for future research in the solid waste collection industry and at the same time has helped bring attention to the benefits of mechanization.

The City of Scottsdale will continue to develop mechanized vehicles and expects to mechanize all residential collection within the city by late 1973. We encourage interested parties to visit Scottsdale and view the system first hand. We feel that the benefits of mechanization have been successfully demonstrated and hope that other communities will take advantage of mechanizations' lower cost, better service and improved work conditions.

PROBLEMS IN SOLID WASTE COLLECTION

Solid waste collections is expensive and rapidly becoming more expensive as wages, working conditions, per capita generation, haul distances, burning prohibitions, service demands and other factors combine to increase unit cost of collection.

Each day U. S. communities collect more than 630,000 tons of solid waste requiring the services of over 350,000 collectors and drivers who collect about 1.8 tons each per man-day and serve 600 people. The cost to taxpayers in the U.S. is approximately $5 billion annually of which $4 billion, or 80%, is spent on collection and $1 billion, or 20%, is spent on disposal.

The problem of solid waste collection and disposal is further complicated by the fact that the industry has a higher injury rate than most occupations. The Bureau of Labor Statistics found that in 1968, the injury rate among solid waste collectors in the public sector was higher than the rate for coal miners, policemen, firemen or loggers. In a 1967 study in California, the injury rate among refuse collectors was almost six times the average for all California industries.

Present Collection Systems Lag

Present residential collection systems include several kinds of equipment. Many cities use various models of rear loading or side loading collection vehicles, while a few use a train system of open trailers, towed behind small trucks, and transferred into large packer trucks. Almost every city uses a system in which the generator places refuse in a number of relatively small containers which are often transported, and usually picked up and dumped into a truck or trailer by a workman who handles each container.

Some cities and private collectors serve a large container by mechanizing the collection process. But mechanization of collection and use of large containers has been limited to multi-family residential units and commercial or industrial generators. Householders have been unwilling to transport refuse far enough to accumulate enough material to make large containers and service trucks economically competitive. Based on Scottsdale's costs for conventional 4 yard containers, using standard front loaders, residential service would be economically competitive where each container served an average of about 10 homes. Such service is acceptable for apartments, but in single family areas it would be difficult to induce householders to transport refuse the average 100 feet or more from their property line to use such containerized service.

These existing solid waste collection methods have important disadvantages that must be corrected if residential collection is to be improved and costs reduced. They need correction if collection agencies are only going to hold

their own against increasing volumes generated. Many analysts believe that the current generation rate for municipal refuse of 6 lbs. per person per day will double by 1985.

High labor costs is one major disadvantage of refuse collection systems that rely on manpower to pick up containers. Labor costs for conventional systems normally account for two-thirds or more of the total cost.

Some of our larger cities must pay workers over $10,000 per year to attract people to their collection crews. Even at low wage rates, however, mechanization means fewer employees to accomplish collection and, thus, reduced labor costs.

Another problem encountered in traditional collection methods is the stigma attached to the job of refuse collector. Few people aspire to become garbage men nor do they encourage their children to seek the position. Few occupations require so much exertion. Collectors often walk as much as 11 miles per day and handle 6 or 7 tons of materials including 2 tons of containers.

Normally, householders provide their own containers, which must be small enough to be easily handled by householders and collectors. These containers are accessible to dogs, rats, flies, and other animals which tip them over, strew their contents, create a nuisance, spread disease and contribute depreciating effects to the neighborhood.

Taxpayers in general and municipalities in particular, have realized the effects of an economic dilemma. Taxpayers object more and more strongly to increased taxes. Income for typical cities increases 5% per year, but cost of services increases up to 15% per year. Despite the resulting incentive to increase productivity, little has been done. Few changes have been made in municipal practice to reduce cost or to increase productivity of increasingly costly labor.

In the current climate of increased concern about the environment, about improved standards of living for the poor (including refuse collectors in many cases), and about unionization of public employees, labor rates for refuse collection have risen fast. Realizing that recruiting willing, capable workmen at the rate of 1/600 people served is a tough problem, many organized groups have taken advantage of the situation to demand increased compensation. The problems, of course, are only beginning. More resources should be put into the development of reasonable alternatives.

These problems, high labor costs, increasing per capita generation, increasing haul distances, container cost to homeowner, poor sanitation, litter accumulation and the difficulty in hiring good workmen have all contributed to a public reaction that demand solutions and cost reductions.

Despite the magnitude and seriousness of the solid waste collection and disposal problem, little research has been conducted to find better methods and practices. This report represents an effort by the City of Scottsdale and the Environmental Protection Agency to attack the problem where the most savings are to be made in the $4 billion spent annually on collection, or the 80% of the total National expeditures on solid waste management.

The Scottsdale Demonstration Project

In March 1964, the City of Scottsdale began providing municipal refuse collection service. Prior to that time, refuse collection was provided by a private collector.

When the city began collecting its own refuse, a train system was established. Each train required two collectors and one non-collecting driver that used a pickup truck and four 5-yard trailers. Thirty-yard front loading packer trucks were used to transfer the trains for the haul to the sanitary landfill while the trains returned to collection routes.

Before containerization, Scottsdale collected with eight trains and three packer trucks on residential pickup. This work force provided twice-a-week collection.

Even though trains are quite economical when compared to other conventional systems, costs were high, willing workers hard to find, and the oppressive summer heat very enervating. A better method was required.

After a look at the safety record and particularly of the effects of Scottsdale's 120°F summer temperatures (several employees had suffered from heat stroke, dehydration and heat exhaustion), a staff study was initiated. At this time, a group of Scottsdale officials conceived the ideas for containerization and mechanization, made preliminary economic projections, and applied for a Federal grant to develop their concepts. The grant was awarded and the demonstration project extended from March 1, 1969 to June 30, 1972.

In general, Scottsdale proposed to demonstrate the feasibility and economy of containerizing household refuse and mechanizing its collection and hauling. This broad objective called for development of a group of new pieces of equipment which would reduce overall costs, improve service to the customer, improve working conditions, and improve the sanitation and appearance of the collection stations.

The following objectives were listed in the grant applications:

For the containerization and initial mechanization using Godzilla (mechanized collection prototype) and the Barrel Snatcher (telescoping arm-front loading collection vehicle):

1. Determine the feasibility and public acceptance of a system of containerizing residential refuse, including an analysis of the size of container, frequency of service, sanitation, efficiency and economy and service combinations.

2. Develop a mechanized refuse collection vehicle to handle the containers and test the feasibility of a mechanized refuse collection system.

For the Litter Pig (mechanical arm side-loader):

1. Demonstrate and report on the operation of the Litter Pig in terms of durability, controlability, maneuverability and training required to operate.

2. Measure and report the costs of operation, the speed of pickup, and capacity under the conditions of service in the experiment.

For the Trash Hog (mobile transfer station):

1. Demonstrate and report on the operation of the Trash Hog in terms of durability, safety, controlability, maneuverability and training required to operate.

2. Collect and report on the costs incurred by the use of the Trash Hog and the savings and increased productivity for collection vehicles.

In addition to these stated objectives, the demonstration produced a good deal more useful data which is included in this report. Scottsdale's experiences with publicity, with retraining displaced employees, with public and employee attitudes, with container maintenance, spraying, repair, modification and specifications, with equipment maintenance and improvement will be of interest to the reader or potential user. Additional specific data or information will be furnished on request.

DESCRIPTION OF AREA

Population and Economic Characteristics

The City of Scottsdale is a community of 80,000 people located approximately eight miles northeast of the center of Phoenix, Arizona. The City was incorporated in June 1954 and undertook a major annexation in 1961 that doubled its population. From 1960 to 1970 the City grew from a population of 10,026 to 67,823 and expanded in size from a small crossroad community to a city that extends from McDowell Peak on the north, southward 16 miles almost to the Salt River, and from the city limits of Paradise Valley and Phoenix on the west, to the boundary of the Salt River Indian Reservation on the east. (See Table 1)

TABLE 1

SCOTTSDALE POPULATION
1940 - 1970

Year	Population	Area of City (Square Miles)
1940	743	--
1950	2,032	--
1960	10,026	3.8
1970	67,823	75.0
1972	85,000 (estimate)	78

SOURCE: U. S. Census, City of Scottsdale, Public Works Department

Although many of its residents work in other parts of the Phoenix metropolitan area, Scottsdale has several major industrial facilities, is a popular vacationing site, and serves as a regional shopping center for an area that substantially exceeds the City's boundaries.

The residential collection area consists of homes of middle and relatively high income families on typical 7,000-square-foot suburban subdivision lots. About 80% are served by alleys and 20% served at the curb. Single-family collection is provided on a twice-per-week basis at no charge to the resident. Subdivisions have been laid out to provide curvilinear street arrangements, so that collection routes must include turnarounds and doubling back.

The City's economic base is evidenced by the fact that the median income in Scottsdale in 1970 was $12,750 with the largest percentage in the $15,000 - $24,999 range. Table 2 summarizes household income by income range.

TABLE 2

1970 SCOTTSDALE HOUSEHOLD RANGE

Income Range (dollars)	Percent of Households
Under 3,000	2
3,000 - 4,999	4
5,000 - 7,999	10
8,000 - 9,999	11
10,000 - 12,999	21
12,500 - 14,999	15
15,000 - 24,999	26
25,000 and over	11

SOURCE: 1970 U. S. Census

Of the 21,373 year-round housing units, 78.4% are owner occupied. The median value of owner occupied homes in 1970 was $22,900. Scottsdale's population lives in relatively new, medium value homes, and has relatively higher income than surrounding cities.

Physical Land Features

The topography in Scottsdale is generally flat. The land drains to the south through a wash that traverses the length of the city. This wash is the only natural feature that hinders collection when flooding occurs, normally about once a year. The flat terrain gives Scottsdale an ideal collection topography.

Climatological Data

The temperature in the City of Scottsdale ranges from freezing to 70° in the winter and from 70° to 120° or above in the summer. The average daily minimum and maximum temperatures for each month with the percent sunshine expected is presented below in Table 3.

TABLE 3

AVERAGE DAILY TEMPERATURES BY MONTH
Scottsdale, Arizona

Month	Average daily max. temp. (of)	Average daily min. temp. (of)	Percent possible sunshine
January	66.1	43.6	83
February	66.2	39.8	81
March	72.5	41.2	79
April	84.7	52.3	92
May	94.6	61.9	96
June	99.4	69.0	97
July	104.9	81.3	85
August	106.1	82.7	87
September	99.0	73.0	99
October	83.6	55.3	91
November	74.0	50.2	75
December	67.5	42.1	87

SOURCE: U. S. Environmental Science Services Administration

It should be noted that the relatively hot summer temperatures have contributed to Scottsdale's interest in mechanization. It has been difficult to keep crews working during hot summer months.

The average daily relative humidity at 10:00 a.m., 3:00 p.m., and 8:00 p.m. varies from 11.9 percent at 3:00 p.m. in June to a high of 59.4 percent at 10:00 a.m. in February. Table 4 summarizes average daily relative humidity by month and time of day. Scottsdale has a relatively dry climate.

TABLE 4

AVERAGE DAILY HUMIDITY BY MONTH
Scottsdale, Arizona

	Time		
Month	10:00 a.m.	3:00 p.m.	8:00 p.m.
January	54.3%	33.7%	51.4%
February	59.4	37.4	54.6
March	52.1	32.8	46.7
April	28.7	17.9	24.2
May	20.8	12.8	16.1
June	19.1	11.9	15.0
July	34.6	24.8	30.7
August	37.3	24.4	31.8
September	35.3	15.7	22.1
October	34.0	18.6	32.5
November	45.8	30.3	47.3
December	49.0%	29.9%	46.5%

SOURCE: U. S. Environmental Science Services Administration

Precipitation in Scottsdale and the surrounding area is negligible as evidenced by the low humidity averages in Table 4. Rainfall hinders collection efforts little, unless flooding occurs. Table 5 presents the total precipitation for 1970, a typical year:

TABLE 5

1970 TOTAL PRECIPITATION BY MONTH
Scottsdale, Arizona

Month	Precipitation (inch)
	T *
January	.43
February	2.11
March	.02
April	.02
May	.00
June	.30
July	1.50
August	4.08
September	.94
October	.04
November	.30
December	
Total	9.76

SOURCE: U. S. Environmental Science Services Administration

* T = Trace

Wind velocity for the Phoenix metropolitan area has a yearly average of 5.9 miles per hour. Table 6 summarizes average wind velocity and prevailing wind direction by month. The low velocities have enabled the City of Scottsdale to utilize open trailers in its train method of collection. Problems with blowing trash and litter are minimal. The occasional summer thundershower includes winds of high velocity which reshuffle the trash as well as some of the real estate.

TABLE 6

WIND VELOCITY AND PREVAILING WIND
Direction By Month
Phoenix, Arizona

Month	Wind Velocity (mph)	Prevailing Wind Direction
January	4.9	East
February	5.5	East
March	6.2	East
April	6.5	East
May	6.6	East
June	6.6	East
July	6.9	West
August	6.3	East
September	6.0	East
October	5.5	East
November	5.0	East
December	4.8	East

Solid Waste Generation

Generally growth in amount of solid waste collected has exceeded population growth. The following table indicates the amounts of waste collected each year by the services offered by Scottsdale. Note that commercial collection includes all materials collected from the large steel containers furnished by the city to merchants, industrial plants, apartments, townhouses and institutions. Brush collection service is limited to residential generators served by the residential collection system. In the five years presented in the table, volume grew 62% over the 1967-68 level. During the same period, we estimate that population grew from about 64,000 to 72,000 an increase of about 13% and the volume of refuse collected grew from about 0.70 tons per capita in 1967-68 to about 0.85 tons per capita, an increase in generation rate of about 20%.

TABLE 7

TONS OF SOLID WASTE COLLECTED IN SCOTTSDALE

Waste Source	1967-68	1968-69	1969-70	1970-71	1971-72
Residential	27,654	28,964	32,758	36,377	39,105
Brush Collection	1,200	2,056	2,562	3,256	4,156
Commercial	16,890	18,201	20,380	24,661	31,172
Total	45,744	49,221	55,700	64,294	74,433

SOURCE: City [illegible] cottsdale Refuse Division

Current Waste Collection Programs

The City of Scottsdale has a Council-Manager form of government with the City Manager as the executive head of the organization. Working for the City Manager, the Public Works Director is responsible for a wide range of activities including solid waste collection and disposal as well as street and sewer maintenance, equipment maintenance, engineering, building inspection, water and sewage operations, and traffic engineering. The Refuse Division handles solid waste collection and disposal and is the organization unit responsible for the four solid waste programs described below.

Residential Containerized Program

The Residential Containerized Solid Waste Program is designed to provide twice-per-week collection service from 80- and 300-gallon plastic containers utilizing one-man operated refuse trucks and a transfer trailer. This program is the heart of the demonstration project as it involves the experimental, mechanized vehicles. Collectors work 40 hours per week, in four 10-hour days, Monday, Tuesday, Thursday and Friday. Work and scheduling problems have been minimized. Three men, classed Equipment Operator III, are employed in this operation as of December 1972. They operate two Barrel Snatchers and one Litter Pig. They serve a total of 3078 containers, 1924 300-gallon containers in alleys and 1154 80-gallon containers for curb collection. They are supervised by the residential collection foreman and receive container repair, maintenance and assembly, and Trash Hog operation support from the Commercial collection section. They serve 7253 homes, from alleys and 1154 at the curb.

Residential Non-Containerized Program

The Residential Non-Containerized Program collects waste twice-per-week from homeowner provided containers, utilizing the train system and side-loader. Collectors now work a standard eight-hour, five-day work week using Wednesday to clean up backlog, pick up sidewalk litter containers, back up brush collection, help with container repair and other activities. As of 1 July, there are four train crews of three men each, one sideloader crew of two men, a foreman and three Equipment Operator III employees, using six pickups, three big packer trucks, and two-axle sideloader. They collect from 11,524 residents.

Commercial Refuse Program

The Commercial Refuse Collection Program is designed to provide for removal of refuse from apartments, schools, condominiums, industries, and businesses on a twice-per-week basis utilizing large steel containers, served by 30-yard front-loading packer trucks. Five trucks regularly collect an average of 130 containers per man day, working on the same four-day, ten-hour schedule as containerized residential collectors. Six employees, a foreman, five Equipment Operator III's and a three-man container repair and maintenance crew

provide this service.

Brush Removal Program

The Brush Removal Program provides for collection of brush and debris which cannot be placed in containers because of size or weight from public alleys and other residential collection stations. Service is limited to areas served by containerized and non-containerized residential services. It is provided by four three-man crews who use 30-cubic-yard, two-axle dump trucks towing trailer-mounted chippers. Because of brush accumulation, collection is provided at regular two-week intervals to each home in the city.

In addition to the staff enumerated above, the Superintendent has a staff of three women specially selected and trained as Service Representatives to handle complaints and to take care of public relations problems for the Division. Most of their efforts are devoted to residential problems.

Operations of the Division and responsibilities of the public are regulated by a refuse collection collection ordinance patterned after the model ordinance prepared by International City Management Association. The ordinance provides that appropriate sized containers must be furnished by developers and builders before service is initiated. All new service in the city is now containerized.

Disposal service is provided on the neighboring Salt River Indian Reservation under the terms of a contract signed by the City of Scottsdale, Mesa, and the Indian Community Council. Disposal is by sanitary landfill, using a modified area method. Material to be disposed is dumped on top of the completed fill and spread, compacted, and covered by a D-9 Caterpillar bulldozer and a large Bros steel-wheeled compactor supplemented by a motor grader, water truck and self-loading scraper.

PHASE 1: FEASIBILITY AND ACCEPTABILITY OF CONTAINERIZED SYSTEM

The main objective of Phase 1 was to determine the feasibility and public acceptance of a system of containerizing residential refuse into municipally-owned containers. Primary consideration was given to size and type of container, frequency of service, sanitation, efficiency and economy of containers, service combinations found to be most desirable to the general public acceptance through questionnaire and oral interviews.

To determine the level of acceptability of a municipally-furnished container receiving various levels of service, five sample areas of about 100 homes were selected. The areas were selected as representative of general conditions in the city and were scattered to reduce effects from various users comparing the level of service they were receiving.

Containerization

Selecting Container Capacity

In order to determine container size, we examined some solid waste generating characteristics in Scottsdale. Our records show that no significant seasonal variation in the generation rate occurs. A random sampling of 36 homes were observed over a two-week period. The following loose volume (gallons) was placed for collection:

	1st week		2nd week		
	1st collection day	2nd collection day	1st collection day	2nd collection day	2-week average
Mean	52	31	47	31	43
Std. Deviation	23	23	21	21	12

First-day collections were made on Monday or Tuesday, and second-day collections on Thursday or Friday, depending on location of the house.

Using this information as a base and assuming a normal curve (as the data fairly well resembles), the following table can be derived:

If a container of this size were provided ...	this percentage of homes would have adequate capacity .... On 1st collection day	2nd collection day	for 2-week period
50 gal.	50%	91%	71%
60 gal.	67%	96%	92%
70 gal.	81%	98%	99%
80 gal.	91%	99%	99%
90 gal.	96%	99%	99%
100 gal.	99%	99%	99%

Based on this data and a decision by the city that 90% capacity was an acceptable level of service on the first collection day, our selection of 80-gallon containers for single families and 300-gallons for four family groupings worked well. The probability of getting four homes together to generate an average of 75 gallons apiece is less than the probability of one family generating 80 gallons due to the effect of multiplying small probabilities.

To test this, using the data gathered, nine random combinations of four homes were made and the gallonage for the homes was totaled for each day over the two-week period. This gave 36 different theoretical collections of four home groups. Of the 36 theoretical collections, one just equaled 300 gallons and the rest were less. Over the two-week period with a 300-gallon container, 1200 gallons could be collected. The highest total of gallons for any of the combinations was 850 gallons.

This analysis of generation was on a random basis and does not take into account factors that may cause variations: for example;

a) Higher income areas tend to generate a higher volume of refuse.

b) Vacation times, holidays and summer yard work increase volumes.

c) Large families sharing a container may generate at higher levels.

d) With a large convenient container householders may dispose of materials, such as grass clippings left on lawns or papers burned, that they previously did not throw away.

Although we do not know the exact effect of these variables, they did not adversely affect any of our experimental areas. However, containers were filled more often than the data predicted. Lack of sufficient capacity is a frequent complaint. We have also found relatively more volume on the first collection day than predicted.

With the generation rate determined, we outlined a program for level of service in each of the five areas using three container sizes as follows:

Container size gal.	Families per container	Collections per week
80	1	2
160	1	1
160	2	2
300	2	1
300	4	2

Container Design Specifications and Costs

We studied several materials for containers. They can be fabricated feasibly from steel, fiberglass or polyethylene. Steel has the advantages of long life, permanence, and numerous fabricators. Satisfactory 300-gallon containers could be delivered for about $90.00 each. They would have the disadvantages of high maintenance and being noisy and less pleasing in general appearance. Also, experimental steel containers were clumsy and difficult to grasp and dump quickly.

Fiberglass containers would require less maintenance and would be pleasing in appearance, but would cost about $120.00. Fabricators indicated that the material is brittle and might have limited impact resistance. We are investigating use of fiberglass products molded using sand as a filler. This method reduces cost and improves strength. Manufacturers have indicated that prices will be competitive, approximately $75.00 per unit. Fiberglass containers failed in use as they cracked when handled repeatedly.

Several experienced manufacturers indicated that polyethylene had the best potential as a container material. It could be cheaply molded, could be protected from ultra-violet radiation, would be pleasing in appearance and would be flexible and strong. Fusion-Rubbermaid of Salinas, California, provided a sample pickle vat which could be modified and handled satisfactorily. County Plastics of Farmingdale, New York, agreed to fabricate a polyethylene 160-gallon container to our specifications provided we would pay for the mold. Accordingly, the project paid the $400 mold cost and received four sample containers using various grades of polyethylene. Tests were run on the modified vat and the sample containers to determine their endurance. Some were filled with 300 pounds of water and dropped from a fork lift. The thinner ones split. We tried a steel ring to reinforce the containers. It tore loose. Plastic tubing was used and it also failed to strengthen the container.

Such experiments and our own judgment helped us determine that a polyethylene container with a minimum thickness of three-sixteenths of an inch would be required to hold up under field use.

We prepared specifications (Appendix A) and received bids on the 350 containers needed for the Phase I experiment. Since County Plastics offered to fabricate containers according to our specifications, and since their price was most favorable, the contract was awarded to them and containers began to arrive the first of August 1969.

The basic patent idea that we were demonstrating included only general conception of the container and a few aspects were left for development. Further, the manufacturer was limited in the materials and facilities available. We were also anxious to proceed and therefore worked out a design for the Phase I containers which was simple to mold and which our forces could modify to test the desirability of furnishing vents.

The 350 polyethylene containers furnished in three sizes - 80, 160, and 300 gallon - were similarly shaped and molded. Lids were separate and were reinforced, equipped with hinges and fastened to the containers by a city crew. The crew installed lanyards to hold lids erect during loading and installed vents in those containers to be vented. Vents consisted of an arrowhead shape about 8 inches long fabricated from about 14-mesh hardware cloth fastened in the middle of the lid. The arrow was to be pointed toward the collection truck when the container was properly oriented. Lids were reinforced with pieces of plywood and hinged with hardware store hinges. The hinges and container were fastened to the lid with $\frac{1}{4}$" bolts. We also experimented with the "polyhinge" (a plastic extrusion, continuous hinge). This proved to be too light and failed repeatedly. Latest designs use a piano-type hinge, reinforced with steel plates inside.

Containers were cone-shaped to accommodate stacking them and dumping refuse from them. They were limited to 45 inches high so they could be conveniently loaded by small children. The containers for curb service were limited to 33 inches wide so they could be wheeled through gates and doors; those in the alley were limited to 48 inches in width to leave ample room to maneuver the collection vehicle beside them in our 16-feet wide alleys.

Containers for curb service were equipped with casters so they could be moved to the curb by generators on collection day. Experience has shown that the casters have some limitations. They did permit use of a simpler container and were easily attached by our assembly crew. On the other hand, they were expensive, costing about $10 per set, and made it difficult to use the container in unpaved areas. Latest container designs provide two 8-inch semi-pneumatic wheels and a handle to facilitate moving the container much like a hand truck.

Our latest specifications permit offers in any material and encourage bidders to warrant the life of containers. Thus, we can compare various materials on the basis of their economics as well as qualitative considerations. The polyethylene costs about $90 for 300-gallon containers.

Several manufacturers have reassured us that the 5-year life expectancy of polyethylene containers is entirely reasonable. Containers currently in use are guaranteed for ten years. On the other hand, containers supplied by our first manufacturer began to show signs of premature failure. Some 20 or 30 of our 350 containers failed in their first year service. Failure in most cases appears to be due to embrittlement from the outside of the container due to ultra-violet degradation of the plastic. The smaller, thinner containers have failed more frequently than larger, thicker containers. We expect that thicker sections and better ultraviolet resistance will provide longer life. Future experience in this area will refine the economic feasibility. More recent containers have been fabricated from new cross-linked material that is working much better.

Acceptable Sanitation

Since we were reducing the frequency of collection from twice per week to one per week in two of the sample areas, we agreed with the Health Department to work under their supervision and to eliminate the once per week

service if they found sanitation problems were created. The Health Department designed a spray program and took fly counts to evaluate the extent of the sanitation problem. Since the lids were fixed to the containers and were normally kept closed, their preliminary conclusions were that the reduction in service did not create a sanitation problem. Periodically spraying lids and interior surfaces with a diluted adulticide also substantially reduced the fly population in the experimental areas. The complete spray program provided for spraying either the container exterior or interior at 2 and 4 week intervals. No containers had serious fly problems. As measured by Maricopa County Health Department, the worst group averaged 1.85 flies per container per week. Larger containers and unvented containers attracted fewer flies. The concentration seemed to be independent of the variations in the spray program. Spraying seemed less significant than nearby fly attractions like dog droppings or spilled garbage.

The Health Department findings show that no changes in the program are required and that, from a sanitation point of view, the new system is generally superior to the old conventional system. The Health Department continues to evaluate the new container system and has encouraged its use and implementation. The staff reported no adverse remarks from citizens contacted during their work.

Prototype Mechanized Collection Vehicle

Modifying Front-End Loader

Container capacities precluded manual collection, and while they were being selected, the City shop worked to modify an existing front-end loader to equip it to handle the containers. A crude sketch of the modification is included in Appendix B. We fabricated a hydraulically-controlled swing arm set in a forklift frame. We turned the frame sideways and attached it to the front-end loading mechanism. The swing arm and opposing hand were fastened to the inner frame of the forklift frame so they could be moved sideways across and out beside the front of the truck. With this modification, the truck was equipped to handle containers from alongside. The truck stops beside and behind the container, the operator moves the pickup unit sideways to engage the container, closes the arm, lifts the container, moves it back to center and dumps it in the conventional way over the cab. He sets the container down by reversing the above process, retracting the inner frame and arm, without having to back up.

The shop developed the control system to give the operator the most efficient combination of controls. The hydraulic system is connected in series since loads are light and in order to give positive control for each action. The controls are separated so the operator can use both hands; one on each side of his seat. Controls operate in the same direction as the corresponding movement of the arm. During each loading cycle, the operator uses four

controls to perform these functions:

1. Move inner forklift frame right to grasp or return container and left to center it in the discharge hopper.

2. Move swing arm in or out to grasp or release container.

3. Move top of forklift frame forward or back to level container while it is being raised and to dump it into the hopper.

4. Raise and lower the arms to dump container.

In addition, the truck contains hydraulic conventional controls to pack or eject the load and to open and close the tailgate.

The truck was not built for speed or efficiency, but only to do a job that couldn't be done by hand. It proved to be economical in operation, however, as the section on economics shows. It has done well and has been retained as a standby unit during Phase II of the experiment.

The truck was completed and ready for normal operation about the first of August 1969. Collection routes were established by choosing the areas that would be representative of the economic spectrum of the city. We chose neighborhoods that were far enough apart that different levels of service could be provided without neighbors becoming concerned by comparing various levels of service in their areas. Two other considerations were:

1. Areas that were convenient for the truck.

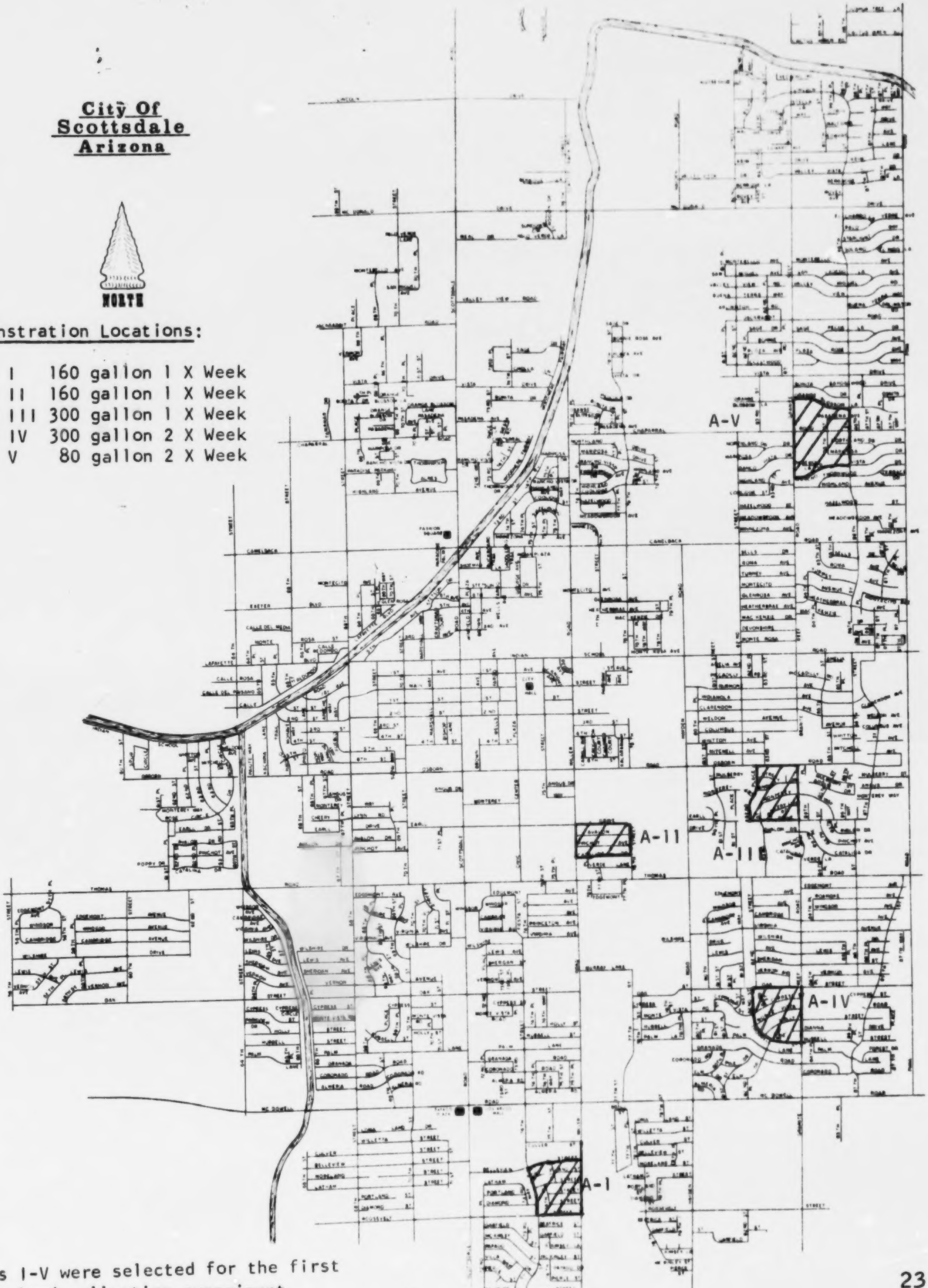
2. Needs of existing refuse system.

Containers were placed in the field during August and September 1969, and collection began. The 80-gallon containers were delivered right to the doors of the people who were not on alleys. They had to roll them from their homes to the curbside on the days of pickup. The 160-gallon and 300-gallon containers were placed in the alleys behind the homes on the routes. There is plenty of room in the 16 feet alleys for pickup so the families did not handle nor make room for the 160-gallon or 300-gallon containers.

Comparative Costs: Mechanized Vs. Train Collection

Although Phase I was not intended to provide data regarding the economics of the system, we did find that the cost of collection with Godzilla was less than with the conventional system. Our conventional train system cost about $1.75 per home per month. Amortizing the $90 cost per 300-gallon container over its expected five-year minimum life and paying all costs of a collection

City Of Scottsdale Arizona


NORTH
A-V
A-11
A-III
A-IV
A-1
CAMELBACK
THOMAS
MC DOWELL

Demonstration Locations:

Area I	160 gallon	1 X Week
Area II	160 gallon	1 X Week
Area III	300 gallon	1 X Week
Area IV	300 gallon	2 X Week
Area V	80 gallon	2 X Week

Areas I-V were selected for the first mechanized collection experiment.

vehicle like "Godzilla", including labor, amortization, haul cost, maintenance, and operation costs to serve the various service areas are tabulated as follows:

Area	Homes per container	Container size (gal.)	Collections per week	Cost per month per home		
				Service	Container	Total
V	1	80	2	$1.42	$0.80	$2.22
I	2	160	2	0.82	0.60	1.42
II	1	160	1	0.58	1.20	1.78
III	2	300	1	0.51	1.06	1.57
IV	4	300	2	0.64	0.53	1.17
Train			2	1.75	0.00	1.75

Obviously even a crude adaption like Godzilla will provide a savings where alleys are available and refuse from several generators can be combined or where homeowners or developers can be induced to provide containers. Note from the tabulation that it is more economical to provide twice-per-week service to a small container than to enlarge the container and provide once-per-week service for alley service. As an illustration, two families sharing a 160-gallon container picked up two times per week, would cost $1.42. If those same two families shared a 300-gallon container picked up once a week, the cost would be $1.57. Providing the larger container would cost $0.46 more than the 160-gallon, while the decrease in service saves only $0.31. As a result, twice-per-week service is more economical and the sanitation advantages of more frequent services will accrue to users.

Public Acceptance of New Collection Concept

Pre-Test Interviews

While the containers were being placed in the field, we took care to visit each generator to explain the purpose of the experiment and the use of his container. We also asked him a number of questions which were used with a post-test questionnaire to determine the level of acceptance of the container system. Samples of the questionnaire and instruction sheets, as well as an analysis of the interviews and description of user attitudes are included in Appendixes C, D, and E. We found that about 98% of the participants were willing to cooperate in the experiment. Less than half of the people interviewed felt that the old conventional collection service was adequate although many were hesitant about trying the new system or sharing a municipally-owned container. Those who were unwilling were kept on the regular collection system until the experiment was underway when several of them then agreed to participate. We made special accommodations to furnish extra containers or to relocate containers to overcome objections.

Operating Experience

We prepared a carefully maintained log of each call from any residents participating in the study. The log indicates the problems we encountered during the early days of operation. When a resident objected to a local newspaper complaint that his neighbors were being used as guinea pigs in the experiment, the newspaper conducted a telephone survey of some 25 persons included in the experiment. None objected and many praised the new system as a considerable improvement over conventional collection. As home owners became accustomed to the new system, we found fewer and fewer objections. We were so encouraged by results, in fact, that we requested permission to order the special collection vehicle to be used in Phase II ahead of schedule.

Post Test Interviews

As explained in Dr. McGaw's report in the Appendix E, "Residential Attitudes Toward Scottsdale Refuse Containerization Experiment", every level of service provided with the container system was preferred by users over the conventional system. Attitudes toward the city and the collection service considerably improved during the experiment. Apprehensions were allayed and users heartily endorsed containerization after experience with it.

The report points out that whereas 60% of the users agreed that the city was doing an excellent job of refuse collection before the experiment, 94% agreed afterward. Users felt that containers should be made more durable, and 8% felt that they should be enlarged. Some users felt that lids should be lighter to accommodate children and some objected to the extra distance they had to walk. Users indicated they most liked adequate capacity (32%); cleaner alleys (21%); and the fact that containers stay covered and don't tip over (12%).

Before the experiment, 55% of the interviewees thought city employees were doing a good job of refuse collection. After the experiment, 94% agreed. Willingness to share a container with a neighbor increased from 55% to 78%, after the experiment, those who had shared, were more likely to agree than those who had not shared.

In all, the staff was pleased with results of interviews. Interviewers were welcomed into homes and reported enthusiastic reception for the experiment. The data and the contacts indicate that containerization achieved among the users.

To compare data obtained in the pre-test interviews with that obtained in post-test interviews and to compare data collected from the various levels of service provided, we developed a simple rating system. The rating system was used to summarize some of the data regarding attitudes to create a crude index of the favorability of the various levels of service. Using 1,000 as a perfect service which every user would agree would be satisfactory, the following indices were developed and arranged in the order in which service was favored (See Appendix E):

	Level of service	Favorability Index
1.	160 gal., one per home, once per week	0.932
2.	80 gal., one per home, twice per week	0.919
3.	300 gal., two homes, once per week	0.904
4.	300 gal., four homes, twice per week	0.868
5.	160 gal., two homes, twice per week	0.860
6.	Conventional train service, twice per week	0.651

All levels of service using mechanization and furnished containers achieved a higher level of acceptance among users than conventional service. Note that once-per-week service achieved a higher level of acceptance than twice-per-week. We feel that this difference results from the extra capacity that is available to the users since containers were sized for first-of-the-week collections.

Based on analysis of the results and considering the economics, we decided to use levels of service numbers 2 and 4 in Phase II.

PHASE II: IMPLEMENTING MECHANIZED COLLECTION

Phase I determined that a system of containerizing residential refuse in municipally owned containers collected by a mechanical vehicle was both feasible and acceptable to residents. Phase II was an extension of the successful research of Phase I. Stated generally, the broad objective of Phase II was to demonstrate the feasibility of various mechanizations of residential solid waste collection. With the prototype equipment on hand, the plan was to work on modifications which would improve productivity. With these improvements, we expected to demonstrate the projected economics by analyzing performance and documenting costs. Corollary objectives of Phase II included the development of techniques to improve public acceptance, publicize the demonstration, measure and find solutions to safety problems and improve sanitation and working conditions.

The specific objectives for Phase II were clearly stated in the applications and are listed below:

Barrel Snatcher (Telescoping Arm Loader)

A. Demonstrate and report on the operation of the Barrel Snatcher in terms of durability, safety, controlability, maneuverability and training required to operate.

B. Collect and report on the costs incurred by the use of the Barrel Snatcher, the speed of pickup, and capacity under the conditions of service in the experiment.

C. Work to improve the Barrel Snatcher in terms of design, construction, safety, durability and economy.

Litter Pig (Articulated Arm Loader)

A. Demonstrate and report on the operation of the Litter Pig in terms of durability, controlability, maneuverability and training required to operate.

B. Measure and report the cost of operation, the speed of pick up, and capacity under the conditions of service in the experiment.

C. Make improvements in the Litter Pig in terms of safety, durability, economy and sanitation.

Trash Hog (Mobile Transfer Station)

A. Demonstrate and report on the operation of the Trash Hog in terms of durability, safety, controlability, maneuverability and training required to operate.

B. Collect and report on the costs incurred by use of the Trash Hog and the savings and increased productivity for collection vehicles.

C. Report improvements to the Trash Hog in terms of safety, durability and economy.

For all mechanized vehicles, our objective was to implement their use in as much of the city as possible to reduce the cost of service and compare the various vehicles to identify the advantages and disadvantages of each.

Collection Equipment

Mechanizations demonstrated in Phase II in addition to old Godzilla previously described, included five pieces of equipment.

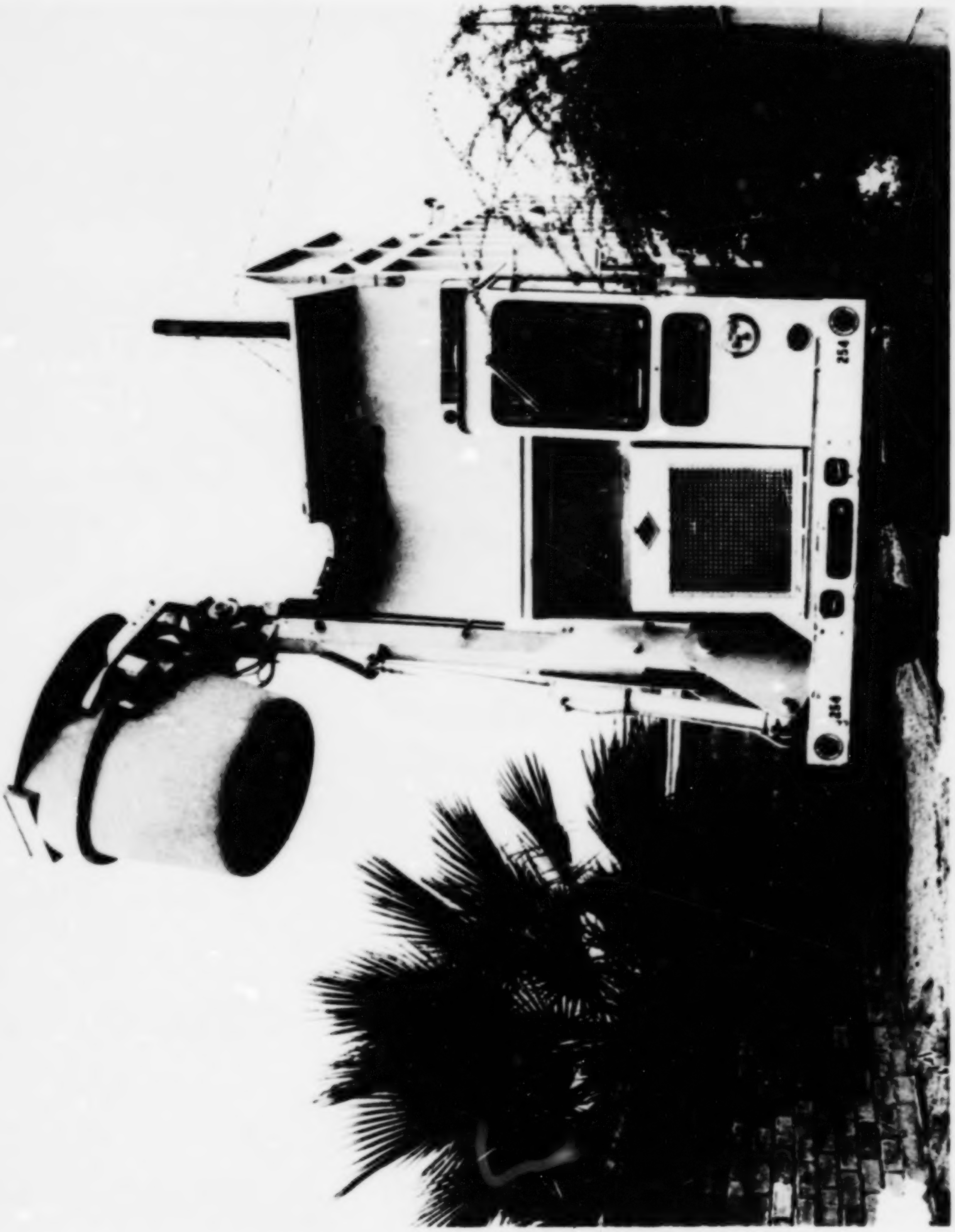
Modified Rear- or Side-Loader

Description. The simplest mechanization is a kit to modify a rear- or side-loading packer truck to equip it to dump the 80-gallon curb containers. The kit is a U-shaped rack into which the container is inserted from the side. The rack is pivoted by a pneumatic or hydraulic ram to dump its contents into the loading hopper. It costs less than $1,000, has a container handling cycle time of about 10 seconds, handles 80-gallon containers, and is fed by hand. Two units may be mounted on each truck so the truck can serve both sides of a street or alley. This mechanization is useful for a small community or one starting a containerization program. It is economically competitive only where homeowners, subdividers or others provide containers.

Final Modifications. To provide a back-up to the Litter Pig, the modified rear-end loader was employed. The operation required two men. One workman would drive and the other would place the 80-gallon container in the yoke, dump the container, and return it to the curb. The vehicle was recently replaced with a Shu-Pak side-loading truck with the yoke mounted on the side. The operation now requires only one man who steps out of the cab, dumps the container, returns to the cab, and drives to the next container.

Barrel Snatcher - Telescoping Arm Loaders

Description. This truck, the backbone or workhorse of the mechanization family, provides the least expensive collection system, is fast, flexible, and has high capacity. It is presently in operation in Scottsdale and known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as the "Son of Godzilla". (Our modified front loader was called "Godzilla".) It empties containers into a 35-yard packer body similar to those used by front end loaders. It is shown in accompanying photos and is equipped with an 8-foot telescoping arm that can be extended to grasp containers 12-feet from the side of the truck. It is operated by a one-hand control designed so the container follows the operator's hand. Controls are electrical and operate the hydraulic system through solenoids. The truck is a special left hand cab-forward Diamond-Reo chassis, may be equipped with gasoline or diesel engines, has two axles and a 7-ton payload. The short wheel base, two-axle design makes it maneuverable enough to operate easily in Scottsdale's 16-foot-wide alley system despite utility poles. It grasps containers from 90° out on the right side of the truck centerline to 50° on the left, and thus can grasp containers past parked cars or collect from both sides of the alley. It has a container handling cycle time of about 15 seconds and handling 300-gallon, four-family containers provides the least expensive collection currently available. It can be adapted to handle 80-gallon containers. The truck complete with diesel main engine auxiliary, engine air conditioning, automatic transmission, high capacity hydraulic pump and other refinements costs about $38,000.

Final Modifications. Phase II was underway with the delivery of the first Barrel Snatcher and containers in August 1970. The new truck, as expected, required modifications to improve their productivity. In the case of the Barrel Snatcher, there were several major structural changes that were needed to secure the boom to the frame of the vehicle. While collecting the large 300-gallon containers in the alley, the boom broke at the base and at the connection to the frame. A much heavier mounting was installed to secure the boom. Another change was required to make the control handle operate as expected. The Equipment Maintenance Division obtained, rebuilt and connected a control stick from a helicopter in the place of the control handle delivered. The result of their effort was a simpler, more comfortable, easier to operate handle. A more complete listing of the modifications to the Barrel Snatcher and other mechanized vehicles is presented in more detail in a later section of this report.

The first Barrel Snatcher was given the 80- and 300-gallon container routes established for Godzilla in Phase I and Godzilla was assigned as a back-up. Because of the Barrel Snatchers higher capability, however, the original routes were extended to serve additional areas by placing more containers in the field.

Realizing that the first Barrel Snatcher was more efficient serving the 300-gallon containers in the alley than the 80-gallon containers at the curb, the routes prepared for the delivery of a second Barrel Snatcher were alley routes. Eight hundred 300-gallon containers were placed in alleys. When the truck was delivered in May 1971, the same modification to the boom mounting was made to avoid the breakage problem. The truck was placed in service and studied for improvements. It was soon noted that the grip hand which grasps the container was open toward the front. The driver could drive up to the container, grip it for dumping, and lift it. When releasing the container to swing the boom away, however, the thumb would hit fences beside the 300-gallon container. The container grip was rebuilt so that it would grasp the container from the alley side of the fence instead of the side toward the truck. The thumb would then open toward the truck instead of toward the fence.

The first Barrel Snatcher required the largest number of changes as expected. Below is an item by item discussion of the major modifications made. Those who are interested in more technical information are invited to contact the Superintendent of Equipment Maintenance.

1. Wiring System. The wiring system of the Barrel Snatcher controls was the cause of constant electrical failures. The system was built with push on connectors. Bolt and nut connectors and larger wire were installed and relays were eliminated to give the truck a heavier duty electrical system.

2. Boom Mounting. The main frame of the boom mounting and the center pin of the boom could not stand the shock of the boom moving and broke several times. A complete new mounting was built from $\frac{1}{4}$ inch rather than 3/16 inch steel. Extra gussets were added and a 3 x 5 x $\frac{1}{4}$ inch oblong tube was extended to the left side of the frame rail. The center pin was extended five inches so that it could fasten to both the top and bottom of the frame. A $\frac{1}{2}$ inch steel plate was added on the bottom of the frame to accommodate the extended center pin.

3. Boom Swing Motor. The hydraulic rotary motor which swings the boom was broken off several times because it couldn't withstand the inertial force of the moving boom. Several sets of bolts were sheared off. A hydraulic ram and bell crank was installed to provide more positive action.

4. Control Handle. The control handle delivered by the manufacturer was bulky and difficult to operate efficiently. To provide a framework for a better and less bulky handle, the control stick utilized in helicopters was obtained and adapted for the Barrel Snatcher. The control has ten separate motions and can be operated with one hand.

5. Boom Speed. In order to increase the speed of the boom and thereby decrease the time needed to grasp and empty the container, 1 inch hydraulic lines were installed from the pump to the control valve. The control valve itself was also replaced with a larger valve. This adjustment proved successful as the boom can now be moved faster and yet not too fast to be a safety hazard. Cycle

time to dump containers was reduced from 18 to 15 seconds.

6. Boom Bearing. The carrier bearing on the inside and of the extension section of the boom wore out faster than would be expected. The bronze plate bushing was replaced with two ball bearings.

7. Container Clamp. To grasp the container, the first truck had to approach the container, extend the boom and clamp, dump, return the container to the ground, retract the boom and clamp and move to the next container. To eliminate the extension and retraction time, the inside finger of the clamp was extended and the outside thumb was cut back. Thus, when the container was returned to the ground, the operator could open the thumb and swing the boom away from the container rather than retracting the entire boom and clamp. This modification reduced the cycle time by several seconds.

8. Boom Stroke. One of the first observations made on the new truck was that the refuse was not being properly dumped into the hopper on the top of the truck. To correct this problem, the apron along the top of the truck had to be cut back and the upper end of the hydraulic hoist ram bracket had to be remounted to give the boom a longer stroke in the up position. This correction also raised the boom off the ground to the level desired for container grasping when the boom was depressed. Previously, the boom would touch the ground fully depressed. We substituted a foot at the top for a foot at the bottom of the stroke.

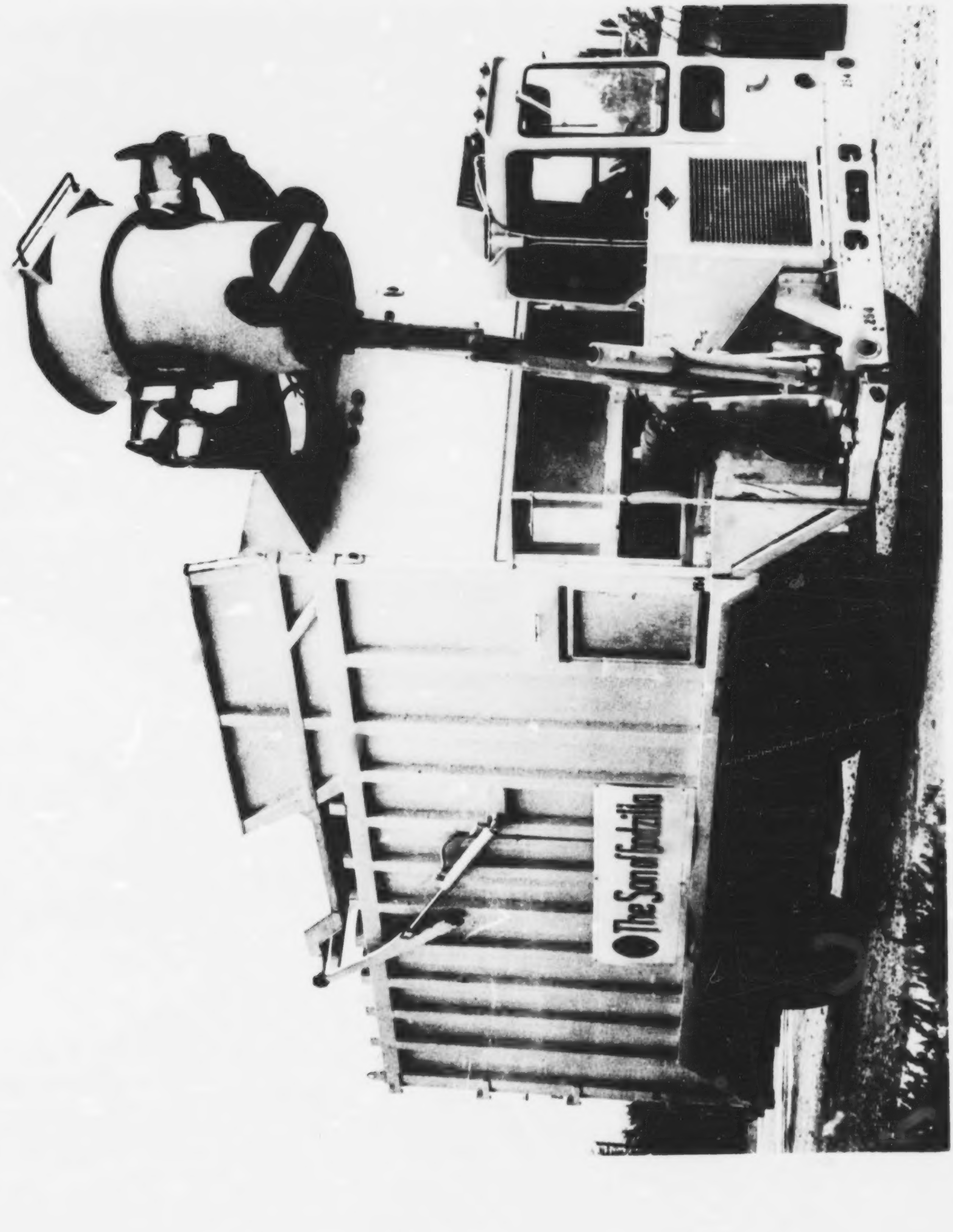
9. Air Control Valve Lines. The truck was delivered with nylon lines for all air control valves. These proved to be inadequate and were replaced with copper tubing.

10. Main Hydraulic Pump. The hydraulic pump which powers the boom was changed from a 19-gallon pump to a 29-gallon pump. The higher volume pump provided more power to the entire boom mechanism.

11. Thumb Hose. The hoses to the thumb and wrist of the clamp originally went through oblong tubing to guide it while the arm telescoped in or out. In this device the hose would double up and wear against itself. A separate pipe was installed for each hose to stop this type of wear and increase hose life.

The second barrel snatcher required many of the same adjustments that the first truck required. The truck was rewired, the boom mounting was strengthened, and the control handle was installed by the shop.

There were many problems, however, which were different primarily because the second Barrel Snatcher was designed to transfer its refuse to the Trash Hog. The back door of the Barrel Snatcher, for example, was not strong


The Son of Godzilla

enough to take the force of compaction. Six sections of the back door have been replaced. The other modifications were as follows:

1. Side Rails. The side rails which carry the packer were modified to carry the packer up and away from the floor. The bearing surface was extended from one foot to three feet and a phenolic plastic was used instead of wood for the bearing. The channels in which the bearings rode also had to be reinforced. These changes enabled the packer to move smoothly on a strong framework.

2. Door Chain. The ram compacted refuse against the door with enough force to keep the door from opening. A two inch hydraulic ram operated a chain arrangement which had one chain to pull up and one chain to close the door. This system was replaced with a five inch ram and two chains for the up motion and two chains for the down motion.

3. Transfer Device. The Trash Hog proved to be too long for the mounting of the centering device for transferring. The centering device was, therefore, mounted on the Barrel Snatcher. The hooks which connect the Barrel Snatcher to the Trash Hog were modified to change the stroke of the arms and the angle of connection.

4. Quick Coupling Unit. Rather than draw power for raising the rear door from the Trash Hog's tractor, a unit was designed which enabled the transfer to be accomplished with hydraulic oil from the Barrel Snatcher. Two hydraulic hoses at the right rear of the trailer connect to the hydraulic system of the Barrel Snatcher. A control panel at the left rear of the Barrel Snatcher has enabled the driver to stand at the point of connection, control the engine and ram speed and open and close the rear door of both the Trash Hog and Barrel Snatcher. The Litter Pig was similarily equipped for transfer.

Litter Pig - Articulated Arm Loader

Description. The Litter Pig is shown in an accompanying drawing (Appendix F) and photo (Figure 2). It consists of Western Body and Hoist's Shu-Pak side-loader equipped with an articulated, back-hoe style arm that reached over parked cars to grasp containers. It had a right hand drive to accommodate manual loading and good visibility. It was operated by a simple one-hand control that worked through electric switches to operate solenoid valves in the hydraulic system. The equipment handled 80-gallon containers and was equipped with an optional orange peel bucket to grasp plastic or paper bags, boxes, piles of shrubbery clippings or other material. It has a cycle time of around 30 seconds. An important design feature was that containers are turned before being released so the operator drove the truck up to a container and away from it without clearing the mechanism away from

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the container. The hopper is cleared continuously by a reciprocating ram.

Final Modifications. The driver of the Litter Pig discovered that the back-hoe style arm was difficult to operate. A telescoping arm loader was designed. Constructed by Arizona Special Products, Inc., the unit bolts to the truck frame behind the cab adjacent to the loading hopper. It is stowed for travel by moving to a vertical position and lowered to frame level for gripping a container. The grips are positioned hydraulically with five axis of movement in addition to the gripping mechanism and movement of the truck.

Without moving the truck the operator can position the barrel grips for engaging a container located anywhere within a 30-square-foot reach area defined by the maximum and minimum reach positions of the arm. While the truck is moving, the container grips can be positioned forward for the pick-up, dump the container and positioned aft for setting the barrel back on its original position letting the driver keep the truck moving.

The unit operates with Racine hydraulics power and controls. Hinge points are reinforced with roller bearings and bushings. All materials and fabrication are in accord with ASTM standards.

Trash Hog - Mobile Transfer Station

Description. As haul distances increase and collection times reduce, it becomes more and more important to increase the size of loads hauled to the disposal site. The last member of the mechanized family - the Trash Hog - is designed for that important job. The trailer has a capacity over 100 cubic yards (specifications are given in Appendix F) and accommodates three loads from the 35-yard Barrel Snatcher or four loads from the 25-yard Litter Pig, or non-stop truck. Trucks have to be modified to work with the trailers. They require special tailgates and beefed-up ejection systems. Trucks back up to the trailers, tailgate to tailgate. A guide aligns the two units so they mate properly. A hydraulic latching mechanism fastens the two units together. Both tailgates are built like a segmented garage door and may be raised by pulling them over the upper rear corner and along the top of the body. With truck and trailer interlocked, hydraulic systems are interconnected. Then, the truck tailgate controls raise both tailgates and the operator may accomplish the transfer from an auxiliary control station at the rear of the truck. The trailer may be set up and left unmanned and with no need for power. With tailgates open, material is ejected from the truck into the trailer. The truck ejection system must provide sufficient force to push material in the trailer from previous loads. It must, therefore, push over 50 feet or 100 yards of material. Each load pushes the next forward in the trailer until the trailer is loaded. With the load transferred, the ejection plate stops at the rear of the truck in a position where its sloped working face can be cleaned off by the tailgate as they are lowered back into place. The ejection plate is slid back as the tailgates lower, and is then retracted to its normal working position.

Transferring does not keep collection vehicles away from their routes for longer than about ten minutes. The Trash Hog is served by a tractor equipped with hydraulic and electrical equipment. It can be handled and set up by one man who must leave the cab only to make electrical and hydraulic connections. He may have a small amount of litter to pick up near the tailgate, but littering is minimal.

Trailers cost around $23,000 each, the tractor about $20,000 and the tailgate and ejection plate modifications start at about $3,000. The system is much less expensive than conventional transfer stations and much more economical in use since the station may be set up in temporary, convenient locations. Scottsdale set up the transfer station in parks, church parking lots, on streets adjacent to vacant lots, on vacant lots and in similar locations.

Final Modifications. The Trash Hog required modification to eject its load properly at the landfill. The truck was designed to eject in two steps. The ram would engage the ejection plate and push the load one half the distance to the door of the trailer. It would then retract and reengage the ejection plate to force the load the rest of the way out. In two motions, however, the ram did not have enough power to eject the load completely. This problem was solved by making holes in the ejection plate for another coupling with the ram. Now the trailer ejects in three motions with enough force to empty the trailer.

As in the case of the second Barrel Snatcher, the mechanism which opens the rear door had to be strengthened. To solve the problem, the door opener chain sprockets were fastened to the hydraulic yoke rather than on each side of the shaft and a larger cylinder and four chains were installed. To accommodate transfer, hydraulic lines were installed so that the Trash Hog could draw its power from the Barrel Snatcher or Litter Pig as noted earlier. The strengthened door mechanism and new hydraulic arrangement with the controls for transfer at the rear of Barrel Snatcher and Litter Pig have greatly improved the transfer process.

Experience With Manufacturers

During the demonstration period we worked with many various industries to develop specialized products. Because we were demonstrating a system with a much higher capital cost than conventional collection systems, and a system which would favorably compete with the best available on the basis of economics, productivity, convenience, safety or sanitation, we expected to have the kind of aggressive interest in product development that would make our task an easy one. We were generally disappointed, however, and a few comments about our experiences may be of interest.

We met with the company several times during 1968 and finally worked out the original concepts for the Barrel Snatcher as a first step in a series of mechanizations that would finally produce a non-stop collection vehicle.

Western agreed to undertake the design and development costs provided the city would purchase containers and demonstrate the equipment in use. Western indicated its intent to patent the idea and to manufacture the equipment as part of its line of refuse collection equipment.

Accordingly, the demonstration grant application was filed and finally granted. After Phase I had demonstrated the success of the concept, we ordered the first Barrel Snatcher and met several times with Western to refine details of the design. Meanwhile, we also applied for grants for the Litter Pig and Trash Hog and received supplementary authorization to demonstrate them. Western agreed to manufacture these pieces of equipment also.

In December 1970, with the first Barrel Snatcher delivered and operating, the second ordered,and the Litter Pig and Trash Hog on the drawing board, Western was purchased by Maxon Industries. After study, Maxon agreed to fill its obligation to deliver the prototype Litter Pig and Trash Hog but indicated no interest in further development, sales or orders for those items. We received numerous postponements and finally threatened to sue for breach of contract. Subsequent deliveries have been delayed to the detriment of the project. The city is now awaiting its third Barrel Snatcher almost two years after the order for it was placed.

During the demonstration period we received less and less interest in our problems and very little support from the manufacturer. Modifications and improvements have been constructed by our equipment maintenance personnel.

To assure a continuing source for improved equipment, we have approached several other manufacturers to try to work out a basis for joint development.

Driver Training

With the receipt of the first Barrel Snatcher, the city was faced with the unique task of training a driver to operate a vehicle that differed considerably from refuse collection vehicles of the time. To accomplish the task, it was decided that a competent, skillful driver would be selected from the refuse crew and essentially, be allowed to learn by doing. A number of containers and obstacles were placed in the refuse yard to create a working situation similar to what the driver would encounter in a typical alley and street. For a week, the driver practiced grasping, lifting, dumping and returning containers to the ground.

When we felt confident that he could control the powerful arm of the Barrel Snatcher, he was sent out on a collection route. Initially, it took the operator as much as an hour to do several blocks of an alley, but within a month he was able to cut the collection time in half. After the initial period of considerable improvement, the operator continued to become more proficient with the arm and truck and settled into a period of slow but steady improvement. In September 1971, for example, the operators of the two Barrel Snatchers were averaging 263 homes per hour of collection. In June 1972, this rate had increased to 271 homes per hour of collection.

The operator of the second Barrel Snatcher went through the same learning process except that he had the advantage of assistance from the first driver. Both operators shared experiences, have helped each other improve performance, and solved driving problems.

The Litter Pig's first driver found the articulated arm quite a challenge. The arm was designed with one more pair of movements than the Barrel Snatcher. The hand and arm was clumsy and frustrating to learn to operate. The driver continued to work hard to master the arm and, after several months, was able to become proficient. The replacement telescoping arm was significantly easier to master. The driver is now averaging over 125 homes per hour of collection.

The 65-feet long Trash Hog poses a different type of driver training problem. The operator must be able to negotiate the sharp turns found throughout the city with safety. During Phase II the Trash Hog was driven by two equipment operators who were selected on the basis of their skill and experience with trailer driving. The drivers learned to handle the long trailer through experience in the yard and in the field and have had no accidents with the vehicle. Part of their success in learning to drive the Trash Hog was their concern for safety and their careful selection of routes to move about the city.

Our Personnel Department has worked out a comprehensive program of instruction and training for new and prospective drivers. Future drivers will be the product of that program and will come to the position with all of the skills except the manual dexterity to operate the controls. We have trained a number of back-up drivers and have found that most drivers develop sufficient dexterity in about two weeks.

PHASE II: CONTAINERS

80-Gallon Container Design and Fabrication

During Phase II, the 80- and 300-gallon containers were modified considerably in both design and construction. The Phase I 80-gallon container, manufactured by County Plastics, consisted of a circular lid, container, and four caster wheels fastened to the bottom. The container was designed to keep the mold simple and to make a container at minimal cost that would do the job. The lid was molded in one piece, reinforced by plywood, cut so that hinges could be installed, and bolted to the container. These improvements made the container usable, but, after a year, breakage of the light 80-gallon containers became a problem. We also found that the small caster wheels made it difficult for householders to move their containers. More improvements were needed.

The next container was purchased from Fusion Rubbermaid and utilized a different lid and wheel arrangement. The container and lid had two matching extensions through which a bar was passed. This bar served both as the hinge to the lid and as a handle to move the container. The caster wheels were eliminated and an axle and two large wheels were installed on the same side of the container as the handle. The homeowner had to pull back and down on the handle and push to move the container. It could be handled much like a hand truck. Although the large wheels and handle arrangement made the container easier to move, the manufacturer was unwilling to guarantee his containers. Each of the first two container models was fabricated from linear polyethylene and protected from ultraviolet deterioration with additives.

The 80-gallon container, now used, was manufactured by Reuter, Incorporated, Hopkins, Minnesota, utilizing cross-linked polyethylene material called CL-100 produced by Phillips 66. The cross-linked polyethylene was expected to withstand the ultraviolet radiation that apparently caused the brittleness and breakage of the previous two container models. The lid and container were redesigned so that a piano hinge, much stronger than individual hinges, could be installed. Brackets were placed inside the container to support the hinge, and a handle was placed on the outside of the container parallel to the hinge, as in the previous model. Finally, the two large wheels were included along with the axle and axle brackets. These containers were guaranteed for five years and later, in 1971, for ten years against failure in normal use. Scottsdale has found these cross-linked, polyethylene containers to be resistant to the effects of the sun and stronger than previous models. Considerable breakage of these containers occurred in Phase II but investigation by the manufacturer indicated that the breakage was due to molding at a temperature insufficient to bring about proper cross linking. Failed containers have been replaced by the manufacturer under the terms of his guarantee. The cost of the 80-gallon container including wheels and brackets was $50.00.

300-Gallon Container Design and Fabrication

The 300-gallon containers went through a similar evolution. The first container consisted of a lid and body. The lid was cut, reinforced with plywood to facilitate hinges, and bolted to the body of the container. Since the 300-gallon containers hold much more refuse, a vent was cut in the lid and a screen was installed. This modification was carried through Phase II to the container now being used. To keep the lid from falling all the way back, a rope was attached on each side of the container. Like the original 80-gallon containers placed on routes in the field, these containers and lids could not withstand the punishment of containing large amounts of refuse and being picked up and dumped by the Barrel Snatcher. The cost of the 300-gallon container was $90.00.

To obtain the advantage of the stronger piano hinge, the back side of the container and lid were flattened. Ropes were again installed to control the lid, but cutting of the ropes by juveniles became a problem. The lids were more than four feet in diameter and were awkward and heavy to handle. The container was made of the cross-lined polyethylene. To solve these problems, a new lid was designed which returned to the original lid in that the lid was cut and the hinge installed along the cut on the top. The small sector was bolted to the container. The movable portion of the lid was molded so it would open to about 100° and stand open. This modification has eliminated the rope lanyards and made the lid much lighter, easier to handle and more efficient. The lid has proven to be light enough for children and oldsters to easily lift with one hand.

Experience With Manufacturers

The biggest capital investment in the system is for containers. In a "set" of containers and collection vehicles, the equipment costs about $40,000 and the containers about $120,000. Further, the set up costs of designing and fabricating molds is much less than the cost of designing and prototyping equipment. So it has been relatively easier to find interested container manufacturers.

Our first contacts were with County Plastics of Long Island, who quickly developed the containers for Phase I. During Phase I we had also contacted Fusion Rubbermaid. Fusion showed a continuing interest in the program and worked with us to develop a suitable 80-gallon container. We purchased 100 of these containers in the Spring of 1970. That company has offered subsequent proposals to furnish containers, but has not offered as competitively attractive a life-price combination as Reuter.

The Reuter Company has worked to develop a functional product and to meet the requirements for guarantees. They fabricated and furnished several trial containers, initiated use of cross-linked polyethylene and have done many experiments to develop and improve their products. They furnished containers guaranteed for five years in 1970, and ten years in 1971. Approximately 1800 300-gallon and 700 80-gallon Reuter containers are now in regular use in Scottsdale.

Interested container manufacturers have been somewhat easier to find and they have worked harder to develop quality products than equipment manufacturers.

Sanitation

Phase I research into the fly problem concluded that, although spraying controlled fly population, the predominant factor in fly concentration is odor created by solid waste on or around containers. In a climate that features temperatures in the 120's, odors can and have accumulated in the City provided containers, especially in the 300-gallon alley containers, which are subject to the hot sun. Drawing from our experience from Phase I, we decided to look for ways to control odor rather than embark on an expensive, comprehensive spraying and container cleaning program.

Since a large portion of households follow the ordinance requiring putrescible materials to be wrapped separately, there are many City provided containers with no odor problem. On the basis of this observation, we decided that our program to control odor and flies would be based on citizen complaints and/or problem areas identified by our service representatives in the field.

Initially, we used the spraying of containers and lids with liquid insecticides. This service required one of our men, a truck and spray unit to go into the field in response to a complaint and spray the container. The service was effective but costly. Chemicals used had to be nontoxic to children who frequently play around the containers.

We were contacted during Phase II by Danner Industries, Inc. of Phoenix, Arizona, who offered Scottsdale a product for testing that could reduce fly control costs and do an adequate control job. This project, called an Ecopak, consists of a plastic container, a powder for controlling odor and perforations in the plastic. The unit has tape on one side and is installed on the inside of the lid of the container. When the lid is opened and closed, a small amount of the powder falls through the perforations into the container. This powder kills bacteria inside the refuse container and thus eliminates all odors, including the cause of most odors, bacteria from food spoilage, etc.

Two hundred units were installed in the 300-gallon alley containers for observation. Our experience with the experiment has been that the powder and the method of dispersion is effective against odors and, therefore, flies. We are waiting for a complete analysis by the Maricopa County Health Department to support or reject our observations. In the meantime, we have purchased additional Ecopaks from Danner Industries, Inc., and are using them in response to fly and odor complaints.

The units cost $.90 each and will last approximately three months. Since few containers need treatment and usually only during the summer months, this relatively high unit cost is small in comparison to the total number of containers in service. The Ecopak can be installed quickly by one person with a hand stapler. We found during the experiment that the tape that came with the Ecopak was not strong enough to hold the unit to the lid. This method has worked satisfactorily and will be used unless Danner develops a better adhesive tape or a new method to secure the unit to the lid.

The alleys which have the 300-gallon polyethylene containers generally have less litter and refuse scattered around than alleys with household provided containers. The 300-gallon containers and lids make the refuse inaccessible to dogs and cats and there are consequently no overturned City provided containers. The polyethylene lids are connected to the container by a strong piano-style hinge and therefore, cannot be removed by the wind, dogs, cats, etc. Homeowners on the other hand, tend to become negligent with their metal and small plastic containers and lose their lids or forget to keep them on their containers. The result of uncovered refuse is more flies, odors and litter.

At the curb, the 80-gallon polyethylene container displays the same advantages over conventional metal and small plastic containers. It is attractive, inaccessible to dogs, cats, and insects and has an attached lid.

From the point of view of pick up, the polyethylene containers are handled by the mechanized vehicles in such a way that little if any refuse is spilled in dumping. The lid does not fall completely open until the container is directly over the hopper. When workmen pick up homeowner provided containers, they inevitably dump some too early or incompletely and spill refuse in the street or alley. Their collection pace is fast and they tend to leave refuse where it is spilled.

The sanitary and litter conditions surrounding the mechanized system and polyethylene containers in summary, have been superior to those areas of the City under the train or rear end loader method of collection. The City is anxious to containerize more of the City to take early advantage of these improved sanitary conditions.

Status of Patents - Equipment and Containers

Any patentable ideas conceived and developed by the demonstration become part of the public domain and are available for use by any one interested. Most of the equipment configurations and the mechanizations demonstrated in this grant, however, were conceived before the grant was awarded and the patent rights have remained with the inventors. The modified front loader, Godzilla, was developed by the grant and plans for this equipment are available on request from the City of Scottsdale. The appendix includes a copy of these plans.

The remaining equipment and the containers were developed outside the scope of this grant. There are two inventors who have applied for patent protection. George Morrison of Western Body and Hoist Company is the inventor of the Barrel Snatcher. His rights to the invention were purchased by Maxon Industries and now vest in that company. The second inventor is M.G. Stragier, the director of this project. He conceived a basic idea for non-stop collection and has applied for patent protection for the device. The application includes protection for the container and the Litter Pig loading equipment. Those two devices are now available for license under the pending patent. Two manufacturers, Reuter and Plastifoam of Denver, Colorado have been licensed to sell containers. John Pickrell of Scottsdale has been licensed to manufacture a loading device similar to the Litter Pig arm and protected by the same pending patent. Otherwise, there are no licensed manufacturers of equipment.

The third inventors are Earl Elton and Howard Smith of Covina, California who own an issued patent for the Trash Hog. The patent gives broad protection for mechanical transfer of cargo between vehicles and is presently available for license.

Social Impact of Mechanized Collection

Residents

Acceptance of Program. The Phase I attitude survey conducted by Dr. Dickinson L. McGaw, Director, Survey Research Center, Arizona State University, showed that participants in the experiment were willing to share and use containers jointly and position containers properly at the curb. The survey also found that before the experiment 55% of the interviewees thought city employees were doing a good job and after the experiment 94% agreed that city employees were doing a good job. These findings were all encouraging and were the basis for our decision to proceed to Phase II and more sophisticated equipment. We felt that it would also be important to examine the attitude of participants after an extended period of use and without the novelty of participating in a new experimental collection system.

During Phase II, Mr. Dennis Schweiger, a graduate student, and members of the city staff conducted a survey (Appendix G), to determine the attitude of mechanized collection customers toward the service provided by the new collection system. Specifically, the survey sought to determine attitude on two questions:

1. Is the new mechanized method an improvement over the old method?

2. Is the refuse being collected satisfactorily by the new system?

The survey was conducted in December 1971 in two separate residential areas that had been receiving the service for at least one year. There was ample time, therefore, for the residents to develop attitudes based upon performance for an extended period. One area was served by the Barrel Snatcher and the 300-gallon containers in the alley and the other area by the Barrel Snatcher and 80-gallon containers at the curb. Both areas were occupied predominately by white, middle class families and were previously serviced by the train system of collection. The survey was conducted after a period in which several equipment failures with the Barrel Snatcher had resulted in erratic service.

The cumulative attitude toward the question, "Is the new method an improvement over the old method" was strongly positive with 72.9% expressing a favorable attitude. In other words, almost three-fourths of those questioned felt mechanization was an improvement over the city's fast train system of collection. Consistent with these results, 75% favored keeping the mechanized system rather than returning to the old manual collection service.

The favorable reaction to mechanization evidenced by the Phase II attitude survey has continued as the Public Works Department has received many inquiries from residents desiring to know when their neighborhood will receive the mechanized service. These inquiries have come especially from householders who are displeased with their alley and have noticed that the alleys with the 300-gallon containers are generally cleaner.

Complaints. An analysis of the complaints received by the Refuse Division in the month of June 1972, revealed that there were fifty complaints pertaining to containerized areas and thirty seven to the non-containerized areas. The larger number of complaints from containerized areas is largely attributable to the fact that the city has been placing a number of new containers in the field each month. It takes several months for homeowners to adjust to sharing a container with neighbors. Of the fifty complaints received, for example, twelve pertained to inadequate container size, six concerned neighbors who weren't using their alley container properly, three residents complained that the container in the alley was too close to their back yard, two that the container in the alley was too far away, and several that the Barrel Snatcher broke the telephone lines.

The complaints from the non-containerized areas predominantly concerned sanitary conditions such as papers in the alley, flies and garbage spread around. These complaints arise because of the open trailer method of collection, transferring by dumping trailers and the numerous small containers which can be tipped over by animals.

All complaints are investigated by Refuse Division "Service Representatives", whose sole job is to handle problems such as those discussed. In containerized areas, complaints such as "the container is too close to my pool," the "container is too far away," and "the Barrel Snatcher broke my telephone wire" are resolved by the service representatives by moving the container to a better location or assigning a household to another container. Messy alley complaints are resolved by issuing clean up orders to the parties concerned or, if the city is responsible, having the city crews clean the alley.

Although the change to mechanization creates an initial surge in the complaint rate, the long range effect showed a reduction in complaints, and an improvement in attitude.

In the Spring of 1972, the Mayor and three of six Councilmen ran for re-election against a slate that belittled the mechanized system, claiming the costs involved were far greater than manual collection. The slate was soundly defeated. Voters demonstrated their attitudes toward the innovative mechanization by reelecting its implementors.

In Spring 1971, the Council began requiring developers of new housing units in Scottsdale to purchase and provide refuse containers with new units. This requirement has met no resistance although neighboring cities are in court for similar changes for park and capital improvements. Several developers have made furnished containers a sales incentive.

In general, the mechanization receives strong public support. The two formal attitude surveys, the requests for service extension, the willingness of developers to provide containers, the willingness of new neighborhoods to accept service, the compliments and general conversation all show that the system produces substantially improved public attitudes. As new habits are formed to accommodate the system, attitudes improve.

Collection Workers

Improved Safety and Working Conditions. As noted in the introductory remarks, statistics show the occupation of refuse collector to be a hazardous one. The solid waste industry, in fact, had the highest injury frequency of any industrial category in 1971 according to the "Work Injury Rate" pamphlet.

This fact is not surprising in light of the nature of the work of the refuse collection. Workmen must jump on and off collection vehicles continually in conventional collection systems. Each day they handle hundreds of containers, many overweight and easy to drop. Some containers have jagged edges that can cause cuts. The possibilities for injury are, in short, numerous.

The frequency rate of disabling injuries is one major criteria to evaluate the safety of an industry. The frequency rate is determined by multiplying the number of disabling injuries times 1,000,000 and dividing the result by the total number of hours worked. For the United States, this frequency rate for refuse collection in 1970 was 90.0 accidents per million man hours worked.

During the period July 1, 1970 through January 31, 1972, or approximately a year and one half, the frequency rate for all four Scottsdale refuse programs was 64 accidents per million man hours worked. This average is considerably less than the 90.9 for 1970 for the industry as a whole and a credit to the Refuse Division's efforts in stressing safety and in the benefits of mechanization.

There are, however, significant differences among our programs. Scottsdale's brush collection program proved to have the highest frequency rate at 99 accidents per million man hours worked. These men, who collect materials including tree trimmings, stumps, and cacti, are subject to a variety of injuries such as flying materials from their chippers.

The next highest frequency rate for the year and one half period is found in the city's conventional collection system which utilizes the train method of collection. The workmen ride the trailers between pickups and can be injured if they fall off or jump off carelessly. They must also lift and empty the containers over the side of the trailer. The frequency rate for this program was 89 accidents per million man hours worked, only slightly less than the 90.0 for the industry for the nation in 1970.

The city's two mechanized systems, Commercial Refuse Collection and Containerized Refuse Collection, demonstrated one of the most important benefits

TABLE 8

ACCIDENT FREQUENCY RATE OF DISABLING INJURIES

1969 - 1971

SELECTED INDUSTRIES

INDUSTRY	FREQUENCY RATE PER MILLION MAN HOURS WORKED
Automobile Manufacturing	1.53
Chemical Acid Manufacturing	6.37
Structural Steel Fabrication	15.07
Highway Construction	16.13
Structural Metal Work	16.58
Logging	17.94
General Building Construction	18.33
Municipal Employees	29.42
Coal Mining	34.29
Parks & Recreation Departments	36.04
Fire Departments	47.32
Police Departments	48.15
Refuse Collection	98.80

of mechanizing solid waste collection. In the year and one half period, there were no disabling injuries in either program. A man riding in a cab emptying containers by controls in the cab simply is not subject to the dangerous conditions that confront workers in conventional systems. He is also more attentive to his work as his working environment is more pleasant. Our Barrel Snatcher, Litter Pig, and most of our commercial drivers work in air conditioned cabs. In a climate that can have temperatures as high as 120^{o}, this certainly is of benefit. The Barrel Snatcher drivers even have stereo tape players to make their work a little more enjoyable.

Less injuries mean, of course, less time away from work, fewer payments for hospitalization and other benefits, and, of course, a better attitude among employees and their families. Although we did not include a cost benefit from safety in our economic analysis, it is a factor that should be weighed heavily in favor of mechanization versus conventional collection when municipalities or private firms compare and study the two systems.

Displaced Workmen Programs. Since the Barrel Snatcher replaces about eight men and the Litter Pig replaces four men, we put special effort into providing for the employees who were being displaced. Some of these experiences may be of interest. Temporary employees have been used to replace employees lost through normal attrition, college students for a special Saturday collection crew, Public Service Careers (PSC) training resources have been tapped and promotion and transfer have been utilized to take care of employees displaced by mechanization. Since most of the displaced employees have advanced to more attractive work and to higher paying jobs, mechanization has been accepted by our employees. They are eager to assist us to implement the remainder of the program.

Use of employees on a temporary basis to do the work performed by permanent employees who have terminated, transferred or received promotions is the simplest method of accommodating containerization. The temporary employee fills the position until he is no longer needed and then is terminated. He is hired for a limited period and knows when he starts work that he can count on employment for only a limited time. During his temporary employment he receives limited fringe benefits and is paid only for the hours actually worked. Many of these temporary employees have eventually received permanent appointments to fill vacant positions. The system works well and offers advantages for training and selection. Supervisors have a chance to work with the man before he receives a permanent appointment, to train him, observe his work habits and acceptance by the rest of the crew. If he is not productive on the job or if no vacancy is available, he is terminated at the end of his temporary appointment.

Several years ago, we began using college students for summer work. We found that they were willing, capable workers, set high standards of dependability and performance and were a good example for the rest of the crew. When they returned to school, we rearranged our work schedule to keep some of them employed working Saturdays.

Full time employees strongly prefer this standard Monday through Friday workweek. It gives them an opportunity to be with their families on the same days off as their working wives, to have two consecutive days off on a regular basis, and to have the same working hours as their friends and associates.

Because of their interest, we worked with our college students and their friends to set up a Saturday crew of college students. Many were athletes who used their Saturday work experience to keep in shape as well as to earn money for gasoline, tuition, board, dating, and so forth. It was a popular and effective program.

We continued to give the front loader truck drivers and the foremen staggered days off and use them on Saturdays to support the college students.

After several years of experience, we began to encounter a few problems. Inconsistent supervision had frustrated the college workmen. The program had become a burden on the foremen because of the personnel handling problems and because none of the four wished to accept the major responsibility to overhaul the program. We placed more containers in the field to eliminate the need for the program and now no longer provide refuse collection service on Saturdays.

The Public Service Careers program, funded by the United States Department of Labor, has helped us provide new employment for employees displaced by mechanization. PSC retrains these employees for jobs in other departments. The program, for example, has trained one of the refuse collectors for the position of Street Maintenance Man I in the Street Division. This employee was subsequently given on-the-job training for work on complex traffic signals and was recently appointed to the position of Traffic Signalman. Instead of collecting refuse, he is now servicing electronic traffic control devices. In another instance, a workman was transferred to the Sewer Division and trained as a Sewer Serviceman. Both employees ended up in higher paid jobs because of the Public Service Careers program and their own interest in self improvement.

Promotion and transfer, in addition to the PSC program, have assisted in our efforts to retain employees no longer needed. Vacancies created in the Refuse Division itself, by retirement, or individuals who have quit their job are one source of placement. Some displaced workmen have been promoted into positions in Brush Removal, Commercial Collection, and Non-Containerized Collection.

Workers have also been transferred into vacant positions in other departments. Men who formerly collected refuse are now found in positions such as sewer serviceman, sweeper operator, parts man, and parks maintenance man. In most cases, their transfer has been to a higher paid job.

Our careful placement of displaced employees in good jobs has kept morale high in the Refuse Division. Employees know they will have an opportunity to apply to become one of our mechanized vehicle operators or that the staff will make every effort to locate for them another employment opportunity including the provision the training required for jobs at higher skill levels.

Aids to Phase II Implementation

Public Relations

Solid waste generators in Scottsdale as in all cities in the U.S. take an intense personal interest in their refuse collection service. The service is visible as residents can observe both the refuse crews and the results of their work several times each week. Solid waste collection, in short, is one of the most important ways citizens judge the efficiency and effectiveness of their local governments.

The City of Scottsdale, therefore, has been cautious and thorough in its public relations program. Throughout the experiment, extensive use was made of local and national press, radio, and television stations, magazines, and professional publications.

To begin with, interest catching and somewhat unique names were selected for the various vehicles in the mechanized family. The modified front end loader used in Phase I was called "Godzilla" and became known nationally as Scottsdale's trash eating monster. The first Barrel Snatcher was given the label "Son of Godzilla" to draw a connection with the original Godzilla and to take benefit from the popularity of that name. The side loading mechanized vehicle was called the "Litter Pig" and the mobile transfer station was named the "Trash Hog." These names created a more positive attitude toward the mechanization project.

When the first Barrel Snatcher was delivered to Scottsdale, City Council member Mrs. Warren Gentry established a first for the solid waste collection industry by holding a tea party in honor of the new arrival. The party, which drew more than 100 local women, was held in the Council Chambers of Scottsdale's City Hall, and was characterized by candles, sterling silver, cookies, floral arrangements, and even piano music from the balcony. The "Son of Godzilla" was cordoned off in the parking lot where it could be inspected by the ladies. The Mayor and Public Works Director addressed the women explaining how the mechanized vehicle and containers will work and Mrs. Gentry followed the presentations with a film, shown on a split screen, of a race between the Son of Godzilla and a manual collection crew. Each provided service to 28 homes. The Barrel Snatcher won by 2½ minutes. The party gained national attention for its uniqueness and generally aided the reputation of the new collection vehicle.

The "Son of Godzilla" was also introduced to the children of the community by demonstrating it at several schools and parks. The children were allowed to get behind the controls and get a feeling for how it operates from the cab. It was felt that the children would communicate to their parents their exciting experience at the school or park and once more bring the taxpayer's attention to their mechanized vehicle.

Before containers were placed in a new area, employees of the Refuse

Division originally called on each home to explain the new system, emphasizing its advantages and offering to return to work out any problems. Since the system received such wide and favorable publicity, we found that this practice was no longer essential. Instead, if the resident is not at home, a letter is left at the door. The letter (Appendix C) explains that the residence has been selected to receive "Scottsdale's unique containerized refuse collection system" to assure better collection service. It describes how to dispose of refuse, how to handle the new container, and what to do with extra refuse. Finally, the letter gives the name and telephone number of the service representative to contact if there are any problems, recommendations, or complaints.

We have found that the best way to handle the containerization of new areas, enforcement of refuse ordinances, inquiries, or complaints on any of the city's collection program is to employ service representatives. Our experience has shown that women are significantly more effective in this position than men. A large part of the day-to-day refuse service work is with housewives who are home during collection hours. Men, even dressed in a city uniform, tend to frighten housewives who frequently are home alone and often embarrassed by their appearance. When our lady service representatives knock on the door, housewives are more inclined to be receptive, cooperative and less frightened. In dealing with men, female service representatives are again more effective than male representatives. Men can be argumentative and resent the city telling them, for example, "to clean the alley." When a woman approaches them regarding a littered alley, however, they tend to be embarrassed that they allowed their alley to get that bad and, generally, politely agree to comply. As citizens learn that they can reach these service representatives at any time of the working day to ask questions or present complaints and because service representatives have been able and tactful enforcers of the city's solid waste regulations, the service representative position has been a valuable and successful part of our public relations program.

Locally, Scottsdale has taken advantage of the public relations capabilities of newspapers and radio and TV stations. Opportunities to publicize the mechanized collection system have seldom been allowed to pass. During the recent celebration of 1972 Public Works Week, for example, the local newspaper was invited to run a photo page on the Public Works Department. Predominant on that photo page were pictures of the Barrel Snatcher, Trash Hog and Litter Pig. The Mayor, City Manager, and Public Works Director have been invited to discuss Scottsdale's mechanized program on radio and TV programs. They have also made presentations to local civic groups such as the Chamber of Commerce, League of Women's Voters, and Earth Day Forums. These presentations have been an important means to expand the community's knowledge of the mechanized refuse program.

The City of Scottsdale publishes a quarterly brochure called "Steps Forward" which contains information and pictures of the various activities of the city. Steps Forward is made available to many of Scottsdale's citizens as a utility bill filler and is used by the staff as a mailing item answer to written inquiries. As early as Summer 1967, the Public Works Director was preparing Scottsdale for the mechanization experiment through an article in Steps Forward entitled "City Organizes Trash Revolution." In the Spring 1969 edition, an article notified the public that they would be questioned on their reaction to Phase I of the experiment. Other articles on the progress of the experiment have appeared periodically to keep Steps Forward readers informed of our progress.

The Scottsdale mechanization experiment has received nationwide attention that indirectly has helped our local public relations program and perhaps, more importantly, raised interest in mechanization and its possibilities in other communities. Scottsdale's program has been discussed in over fifteen articles which have appeared in such magazines as "Fortune," "The American City," "Waste Age," "Nation's Cities," "Public Works," and "Western City." It has also been featured in "Weekly Reader" and the "Christian Science Monitor". A bibliography of these articles is included. Public Works Director, Marc Stragier, recently appeared on a talk show on a Seattle TV station and has made a number of presentations to nationwide professional organizations such as the Western Division of Governmental Refuse Collection and Disposal Association, and the American Institute of Aeronautical and Astronautical Engineers at Albuquerque, New Mexico, the southeastern chapter of International City Manager's Association, to seminars at the University of Houston, University of Wisconsin and University of Washington. He will present results of our work to the '72 Fall conference of the American Public Works Association (APWA). APWA selected Marc as one of the top ten Public Works Men of the Year in 1972, partly on the strength of this work.

A unique Innovation Conference was held in 1969 in Scottsdale which, although not designed as a public relations effort, certainly drew interest to our program. The conference was sponsored jointly by the U.S. Conference of Mayors, the National League of Cities and "Western City" magazine. Each registrant at the conference was required to present one of his own innovations. Scottsdale demonstrated the Barrel Snatcher and explained its collection systems to the visiting Mayors, Managers, and Department Heads from across the country.

The city also prepared a special summary report describing its work. This report has been mailed or distributed to over 400 cities, private haulers, manufacturers, consultants and others. In addition more than 100 people have visited Scottsdale to watch equipment operate. Numerous slides and movies have been distributed.

Refuse Ordinance

In November of 1970 the City Council thoroughly revised, updated and adopted a comprehensive ordinance regulating refuse handling in Scottsdale. The ordinance (Appendix H) defined the various types of solid waste, gave the city exclusive right to collect refuse and authorize franchises, permits, or licenses, described how refuse is to be contained, established collection procedures, regulated collection from commercial establishments, listed prohibited substances, provided for refuse charges, established the right to lien for collection charges, and listed unlawful acts. The ordinance provides that new generators will provide their own containers, suited for the mechanized system and conforming to city specifications.

According to the ordinance, bulk rubbish and brush are to be placed next to containable rubbish on the scheduled pick up day. No more than ten loose yards can be set out at one time and plants, such as cactus, which are hazardous for collection, must be contained in lengths of less than three feet. The purpose of the bulk rubbish provision is to remove brush, furniture, appliances and other similar materials from the mechanized collection system.

Residential generators are required to place their household or 80-gallon containers on the scheduled collection day. Containers cannot be placed at the curb before six o'clock on the day preceding the day of collection and must be removed by six o'clock on the day of collection. This provision has helped minimize the problem of unsightly containers at the curb on days other than collection days. Where the collection station is located in the alley, containers may be left in place.

The ordinance also requires that city provided containers serving more than one residence be positioned along the rear or side alley not more than one hundred feet from the property line of any residence. The one hundred feet limit was included in the ordinance because it was felt that it would be unreasonable and inconvenient to require a homeowner to carry his refuse further than that distance. In most cases, the 300-gallon containers are within ten feet of the properties they serve.

Since the Barrel Snatcher and Litter Pig cannot lift containers that have been filled with rocks, sand, chunks of concrete or other prohibited heavy materials, a provision of the ordinance sets a five hundred pound weight limit. Unfortunately, overweight containers are encountered daily as residents show poor judgment in their estimation of the weight of their refuse. A truck and crew have to be dispatched to empty the container by hand or remove enough refuse so the collection truck can return. The service representative is also dispatched to talk to the residents concerned.

The resident is responsible for the maintenance of sanitary conditions in the container and in the area surrounding the container. Putrescible materials must be wrapped before placement in the container and liquids must have been drained from the waste. There have been many violations of these provisions which have been investigated and corrected by the service representatives in the Refuse Division. These violations are especially evident in the hot summer months when odors develop.

Two important amendments have been made to the Solid Waste Ordinance and subdivision ordinance that have saved the taxpayers a considerable sum of money. The refuse ordinance was amended to require owners or developers of new construction not regulated by the subdivision ordinance to supply, at their expense, refuse containers which become the property of the city. The same requirement was placed on development covered by the subdivision ordinance. The effect has been the containerization of new areas of the city with no investment by the city in containers. The city will, of course, replace the original containers at city expense once they wear out. This requirement has reduced our cost for twice-a week service per home by $.67 per month for areas with curb collection and approximately $.30 per home per month for areas with alley collection.

Scottsdale Plans Advances in Mechanization

Scottsdale expects to continue work to develop and improve the mechanized system.

We are now constructing our own chassis with a midship engine in and under the frame and between the axles. Using this chassis design, with a cab arrangement similar to the Barrel Snatcher, we expect to locate a receiving hopper beside the cab and a mechanism that will dump refuse from beside the truck into the hopper. The shorter travel for containers should greatly improve productivity.

We look forward to the day when we can find a manufacturer ready to work with us to construct a non-stop collection vehicle. Conceptual drawings have been prepared and patent proceedings started on such a mechanization which will serve our existing 80-gallon containers.

We hope to induce a manufacturer to make additional tailgates and Trash Hog trailers so we can expand our use of this equipment. We are anxious to use it on our commercial collection routes.

The last portion of the city will be containerized during the Fall of 1973. Over a third of the city is now served by the mechanized system. Containers and equipment for the next third are on hand or on order and for the last third will be proposed in next year's budget.

We will continue to make the system available for study by prospective users. We can make reservations and coordinate visits for anyone interested and will also provide data sheets and other materials.

Our Council and citizens are satisfied that the improved services and reduced costs provide substantial benefits.

Conclusions

Based upon our experiences and observations in Phase II, we have reached the following conclusions:

1. Containers. The 80-gallon and 300-gallon cross-linked polyethylene containers went through a number of modifications in Phase II. The containers which resulted are strong, attractive, easy to open and dump. They are resistant to the effects of sunlight and are, therefore, especially suited to Arizona's environment. The manufacturer has guaranteed the containers for ten years.

2. Consumer Reaction. In a Phase II attitude survey, nearly three-fourths of the respondents felt that the mechanized system is an improvement over the old system. Complaints change from the subject of sanitary conditions to temporary adjustment problems with the new containers. Mechanization has received strong public support with the reelection of a City Council which has avidly supported mechanization.

3. Public Relations. A strong public relations program can greatly assist in the introduction of a mechanized system. A tea party, school visits, an innovation conference, personal contact by service representatives, newspaper and magazine articles, TV programs, speeches, reports, demonstrations, visits by other officials, and good complaint follow-up have all contributed to a successful public relations program in Scottsdale.

4. Ordinance Provisions. To back up the mechanization program, the City of Scottsdale has adopted an ordinance which regulates containers and their use. The ordinance requires new developers to provide containers for the households in the development.

5. Driver Training. Scottsdale initially trained drivers by setting up a training course and allowing the drivers to learn on their own. Once the first few drivers became proficient, the experienced operators trained the new operators. The system worked well and will become more formalized as new mechanized vehicles are received.

6. Manufacturer Experiences. The support from equipment manufacturer's has generally been disappointing. The interest of Western Body and Hoist in the experimental program dissipated when the firm was purchased by Maxon Industries. We are working with other manufacturers to develop new sources of equipment.

7. Patents. All patentable ideas conceived and developed by the demonstration are a part of the public domain.

8. Safety. Scottsdale's two mechanized programs, Commercial Refuse Collection and Residential Containerized Refuse Collection, had no disabling injuries in Phase II. This impressive record was accomplished in an industry that had the highest injury frequency of any industrial category in 1971.

9. Sanitation. The introduction of the mechanized system with the polyethylene containers has resulted in improved sanitary conditions. Alleys are neater and more sanitary where the 300-gallon containers are used. Flies were controlled in Phase II by reducing odors with a powder unit that is installed on the inside of the container lid.

10. Displaced Workmen. The careful placement of displaced employees in good jobs has kept morale high in the Refuse Division and generated employee support for mechanization.

ECONOMIC AND PRODUCTIVITY ANALYSIS

Perhaps the most important objective of this demonstration project was to evaluate the productivity and economics of each of the mechanized vehicles. To be meaningful, this analysis should compare conventional types of refuse collection vehicles with what, in this report, are called mechanized. We have attempted in this study to make these comparisons based upon our best knowledge of conventional systems and the data we have collected on the mechanized vehicles. We encourage the reader to use data on his method of collection and compare it with the data contained in this report. Only in this way, can the information be of use to your community or firm.

We also encourage the reader to note the assumptions we have based our analysis upon and change these assumptions according to your particular situation. If, for example, the haul time in your area averages .37 hours and the assumption of our analysis is 1.00 hours, the cost per home per month we have tabulated for the mechanized system in relationship to your method of collection will change considerably.

Vehicle Capacity

The vehicles compared in this report are the rear end loader, the modified rear end loader, Godzilla, the Litter Pig, and the Barrel Snatcher. The Trash Hog is discussed in a separate section.

The rear end loader is one of the most commonly used refuse collection vehicles in the United States. The truck normally has a driver and two workmen. The workmen pick up the container or plastic bags, dump them in the hopper in the rear of the truck, and return the containers to their original location. When the hopper is full, a compaction plate cleans the hopper and compacts its contents. The truck has a capacity of up to 25 cubic yards and can contain 250 homes per load in twice per week collection.

The modified rear end loader is a rear loader with a yoke attachment on the rear that will accommodate containers. In Scottsdale's case, these are the city-provided 80-gallon containers. The crew consists of a driver and one workman. The workman grabs the 80-gallon container at the curb, pushes it into the yoke, the yoke dumps the container, and the workman returns the container to its curb location. Like the rear end loader without the yoke, the truck has a capacity of approximately 25 cubic yards and can serve 250 homes per load.

Godzilla, the Litter Pig and the Barrel Snatcher are all one man operated vehicles. Godzilla, the prototype mechanized vehicle, had a capacity of approximately 28 cubic yards and could serve 280 homes per load. The Litter Pig has a capacity of 22 cubic yards and can contain 277 homes per load, whereas the Barrel Snatcher holds 35 cubic yards and will serve 357 homes per load. The data for the mechanized vehicles was acquired by totaling the number of homes served in a specific period and dividing that number by the number of trips to the landfill. The figures are, therefore, averages and the actual number of homes per load at a given time would depend on the circumstances. First of the week collections are heavier and trucks serve less than the average. Second day collections produce more homes per load than the average.

Rate of Collection

Another important factor in evaluating productivity of a collection truck is the rate of collection. The rate of collection may be defined as the number of homes that can be collected in one hour of regular operation with no allowance for hauling.

For the rear end loader, we estimate the rate of collection for typical crews at 85 homes per hour of collection from the curb. These homes, of course, utilize plastic bags, boxes, or small metal containers and there may be more than one container per household.

The modified rear end loader serves 90 homes per hour of collection in Scottsdale. The homes collected utilize the city provided 80-gallon plastic containers and place their container at the curb for collection. The two-man crew using the mechanized loader produces at a faster rate than conventional three-man crews, loading the variety of small containers furnished by each householder.

The Litter Pig, which is designed to pick up the 80-gallon polyethylene container, has a rate of collection of 131 dwelling units per hour of collection. The original Litter Pig design using the back-hoe articulated arm design proved to be slow and cumbersome. The initial Litter Pig design had a disappointing collection rate of 61 dwelling units per hour. With the redesigned telescoping arm assembly, production was significantly increased.

The Barrel Snatcher can serve both the 80-gallon plastic containers at the curb and 300-gallon containers from the alley by simply changing the grasping mechanism. It has an average rate of collection at the curb (80-gallon containers) of 61 homes per hour. In the alley, however, we have found it much more productive. Moving down the alley, the truck can empty 82.1 300-gallon containers per hour of collection. Since each container serves 3.3 homes, the truck actually serves 271 homes per hour of collection.

The faster rate of pick up in the alley can be attributed to the fact that, for curb collection, the truck must negotiate parked cars. Although narrow, there are few obstacles in alleys and containers are located at roughly equal intervals. The driver in the alley is able, in a sense, to establish a rhythm of pick up.

Home-Container Ratio

The home-container ratio is crucial to the costs of the alley collection of the Barrel Snatcher and its prototype, Godzilla. In our original estimates, we assumed that the 300-gallon polyethylene container would serve four households, two on each side of the alley. In actuality, there proved to be several reasons why our average number is less than 4.0 per container.

In establishing our initial routes, we found that there were few blocks in Scottsdale which contain a number of homes evenly divided by four. Frequently, there would be one, two, or three extra homes at the end of the block that would not be in a group of four. Since our policy is not to assign more than four homes to one 300-gallon container, we placed another container in the alley. If there were three extra homes, they were directed to utilize the additional container. If there were two extra homes on the block, one homeowner in the adjacent group of four was assigned to the new container creating two groups of three homes per container at the end of the block. If there was one extra home, one homeowner in the adjacent group of four was assigned to the new container forming one group of three homes per container and one group of two homes per container.

Another factor which lowered our average number of homes per container was the one sided alley. In Scottsdale, there are new developments which, on one or more sides, have vacant land. Consequently, we have been faced with the task of serving only one side of the alley. Where it is possible to place a container within one hundred feet of the user's property line, we have set out one container for three homes. In all other cases, we have been required to assign two homes to one container.

These two situations have lowered our average number of homes per container from 4.0 to 3.6 and later 3.3. Economically, the effect has been to increase the cost per home per month by spreading the cost for service and containers among fewer homes and reducing the rate of collection in homes per hour for the Barrel Snatcher.

Investment Costs

In order to calculate the cost of refuse collection service, a determination must be made of the investment required to purchase the needed equipment and the cost to operate that equipment.

To determine the total investment cost, we have acquired cost information from various communities in the Phoenix metropolitan area and from our own experience, and have assumed three year financing at 10% interest. This rate is not unusual although most municipalities utilize bidding procedures and purchase vehicles outright.

The least expensive vehicle to purchase is the rear end loader at a cost of $27,000 plus $4,050 in finance cost for a total purchase price of $31,050. The yoke attachment to serve the 80-gallon polyethylene containers can be purchased and installed for $1,000 bringing the purchase price of the modified rear end loader to $28,000. Adding $4,200 in financing expense, the total price is $32,200.

Godzilla, as a prototype, is not available on the market. We estimate, however, that it could be constructed by a manufacturer at this time for a cost of $30,000 plus $4,500 in interest expense. The total purchase price would be $34,500.

Although a Shu Pak can be purchased for approximately $34,500, including interest, the Litter Pig, which is a modified Shu Pak, costs considerably more. The adjustments to the truck and the construction and installation of an articulated arm account for an additional $13,000. The vehicle costs $43,000, including adjustments, and, adding the interest of $6,450, the total cost is $49,450.

The Barrel Snatcher is the most expensive member of the mechanized family because of its high performance capabilities. The first truck was purchased for $36,733 in 1970, but our most recent bid for the vehicle was in excess of $50,000. Since this huge increase in purchase price can hardly be accounted for in increased labor and material costs to the manufacturer, we can only assume that the manufacturer is passing some developmental costs on to the customer. Should the vehicle become mass produced, as we feel it will, the cost should drop considerably, perhaps to as low as $40,000 per truck. We will use $45,000, however, for this vehicle. Adding $6,750 in finance charges to this amount, the truck would cost $51,570.

Table 9 shows the comparative equipment investment costs.

TABLE 9

VEHICLE INVESTMENT COSTS

VEHICLE	PURCHASE PRICE	FINANCING COST	TOTAL COST
Rear End Loader	$27,000	$ 4,050	$31,050
Modified Rear End Loader	28,000	4,200	32,200
Godzilla	30,000	4,500	34,500
Litter Pig	43,000	6,450	49,450
Barrel Snatcher	45,000	6,750	51,570

Operating Costs

The operating cost for a solid waste collection vehicle is determined in our analysis by totaling the cost of labor, administration and overhead, operating and maintenance, and amortization of the purchase.

In our tabulation, we have used the present salary schedule of the City of Scottsdale and added 33 percent of the salary to cover fringe benefits. We have also used the job classifications that we would assign to the various members of the crew of each vehicle. The rear end loader is driven in Scottsdale by an Equipment Operator I who makes $656 per month. The other two members of the crew are classified as City Workmen and are paid at the rate of $580. Adding fringe benefits, the total labor cost per month is $2,416. The modified rear end loader utilizes one less City Workman and has a total monthly cost for salary and fringe benefits of $1,636. The Godzilla, Litter Pig and Barrel Snatcher are more complicated to operate and therefore have been assigned to the Equipment Operator III classification. The Equipment Operator III makes $780 per month and another $250 in fringe benefits. The monthly cost for labor for Godzilla, the Litter Pig and Barrel Snatcher is, therefore, the same or $1,030 per month.

To cover the expenses of administration and overhead, 30% of the total labor expense has been added. By using a percentage, we have in essence placed the highest administration and overhead expense burden on the system using the most manpower. In this case, it would be the rear end loader where three employees are required. We feel this is a fair assumption as more administrative effort and support is required for the three-man crew than the one-man crews of the mechanized vehicles. The higher pay of the mechanized equipment drivers, however, offsets some of the effect of applying the straight percentage. The highest administration and overhead expense belonged to the rear end loader at $725 per month followed by the modified rear end loader at $491 per month. Again, Godzilla, the Litter Pig and Barrel Snatcher had the same expense at $309 per month.

Operating and maintenance costs for the collection vehicles studied varies. This cost includes gasoline, oil, lubrication and other routine servicing and repair work. For the rear end loader, our experience has shown that approximately $1,000 per month is needed to keep the truck in good operating condition. Godzilla, when it was in service, required slightly more than the rear end loader or $1,100 per month. The Litter Pig has the monthly average for operating and maintenance expense of $1,005. The Barrel Snatchers have required the highest monthly investment for this purpose because of the many modifications that have been made to improve their report. The two trucks have averaged $1,780 per month but, since a large part of this monthly average has been one time modifications, we have used $1,500 per month in the cost analysis.

The final cost category of operating cost is amortization of the purchase price of the vehicle. For this item, we have assumed straight line depreciation of seven years with no resale of the truck. The resale value was not included because of the difficulty in assigning a value to a vehicle that has been in heavy use for seven years. In many cases, refuse trucks with this much service are worth little more than their scrap value. The amortization cost of the Barrel Snatcher was highest because of its high purchase price followed by the Litter Pig, Godzilla, the modified rear end loader and the rear end loader.

Totaling these costs we find that the highest monthly operating cost was the rear end loader's at $4,511 per month, primarily because of its high labor cost. The operating cost of the modified rear end loader is

$1,000 less per month because it needs one less crew member. High maintenance requirements and amortization cost placed the Barrel Snatcher next in line at $3,455 per month. The Litter Pig's total was $2,933 and Godzilla's was $2,850.

Table 10 graphically indicates the comparative monthly vehicle operating costs.

TABLE 10

VEHICLE OPERATING COST
PER MONTH

VEHICLE	Labor	Administration & Overhead	Operating & Maintenance	Amortization of Purchase	Total
Rear End Loader	$2416	$725	$1000	$370	$4511
Modified Rear End Loader	1636	491	1000	383	3510
Godzilla	1030	309	1100	411	3850
Litter Pig	1030	309	1005	589	2933
Barrel Snatcher	1030	309	1500	616	3455

Cost Per Home (Dwelling Unit) For Service

The basis of the economic evaluation of the various collection systems if the monthly cost of service per home (dwelling unit). To arrive at the monthly cost, a simplified yet valuable costing formula is applied. The formula indicates relative economic performance.

The formula to determine the cost per home (dwelling unit) per month is as follows:

$$\frac{(\text{No. of Pickups/Month})(\text{Cost of Operation/Month})\left[(\text{Capacity}) + (\text{Rate})(\text{Haul time})\right]}{(\text{Work hours/month})\ (\text{capacity})\ (\text{rate})}$$

$$+ \text{ container cost} = \text{ cost per dwelling unit}$$

By factoring the equation an even more simplified formula can be obtained:

$$\text{Cost} = \frac{(\text{No. of Pickups})\ (\text{Cost of Operation})}{(\text{Work hours})\ (\text{Rate})}$$

$$+ \frac{(\text{No. of Pickups})\ (\text{Cost of Operation})\ (\text{Haul Time})}{(\text{Work hours})\ (\text{Capacity})}$$

$$+ \text{ Container cost}$$

The factored equation shows cost as the sum of collection cost, haul cost, and container cost or

$$\text{UNIT COST} = \text{Collection cost} + \text{Haul cost} + \text{Container cost}$$

Comparative cost of service can be determined using the following formula:

$$\text{Cost} = \frac{(\text{No. of Pickups})\ (\text{Cost of Operation}\ \left[(\text{Capacity}) + (\text{Rate})(\text{Haul time})\right]}{(\text{Work hours})\ (\text{Capacity})\ (\text{Rate})}$$

$$+ \text{ Container Cost.}$$

The cost elements of the formula are defined below:

Number of Pick ups Per Month. The number of pick ups per month is the number of times service is provided to the generator. In Scottsdale, as in many communities, refuse pick up is provided on a twice per week basis. Although the number of pick ups per month would average 8.6 for twice a week service, we will assume there are nine pick ups per month for simplification. For once per week service, the number would be 4.5.

Cost of Operation. The cost of operation is the total of labor, administration and overhead, operating and maintenance and amortization expenses for each vehicle expressed as a monthly figure.

Capacity. The capacity of a vehicle is the number of homes the vehicle can serve per loaded trip to the landfill. The capacity varies with the amount of generation per household.

Rate of Collection. The rate of collection is the number of homes the vehicle can serve in one hour of collection excluding haul time.

Haul Time. The haul time is the time required for the vehicle to make a round trip to the landfill. This time depends on the speed of the vehicle and the distance of its route from the landfill. In Scottsdale, the Litter Pig averaged .83 hours for a round trip to the landfill and the Barrel Snatcher .57 hours but the Litter Pig's route was considerably further from the landfill. To make comparison of the various vehicles possible, we have assumed a 1.00 hour haul time.

Work Hours Per Month. The work hours per month is the number of labor hour required to operate the vehicle five days a week, eight hours a day. Since preparation and personal time is relatively constant from one vehicle to the other, we have not deducted these amounts and have simply multiplied 40 hours per week times 4.3 weeks per month for a total of 172 hours per month.

Applying the data we have assembled on the rear end loader to the formula, the cost per home per month is \$3.72.

$$\frac{(\text{9 pick ups})\ (\text{\$4511 cost of operation})\ \left(\text{250 homes per load} + \left(\text{85 homes per hour}\right)\ \left(\text{1.0 hours haul time}\right)\right)}{(\text{172 work hours per month})\ (\text{250 homes per load})\ (\text{85 homes per hour})}$$

$+ .00$ container cost

$$\frac{(9)\ (4511)\ (250 + (85)\ (1.0)}{(172)\ (250)\ (85)} = \$3.72$$

By changing the operating cost per month to \$3510 and the rate to 90 homes per hour, the cost per home per month for the modified rear end loader is \$2.78. Since the city is providing an \$80 eighty-gallon container, however, the amortization of the container must be added to the monthly cost. The containers in Scottsdale are guaranteed for ten years which gives Scottsdale a monthly amortization cost of $.67 per container. The total cost per month per home for the modified rear end loader is $3.45, $.27 less per month for the rear end loader.

The reason for the cost advantage of the modified rear end loader is evident in the operating cost data. Although the vehicles perform similarly in most aspects, their labor costs are quite different. The rear end loader required three operators whereas the modified rear end loader only requires two. During the unproductive one hour round trip to the landfill, three employees are drawing their wages on the rear end loader while only two workers are on the modified rear end loader.

The application of the formula to the costs and capabilities of Godzilla for curb [illegible] ion reveals that it is $.05 more expensive per home per month than t [illegible] loader. This fact, however, is not surprising when it is noted [illegible] la was designed only to demonstrate the principle of mechanizatio [illegible] ot as a high performance collection vehicle. The total cost per home per month of $3.77 includes $.67 for amortization of the polyethylene containers. The savings incurred through the use of only one employee, therefore, is more than offset by the higher rate of collection of the rear end loader and the cost of providing the container.

The Litter Pig with the telescoping arm side loader proved to be the most productive collection system for curbside service. With a collection rate of 131 dwelling units per hour, the Litter Pig cost of curbside collection including container amortization was $2.25 per home for twice per week collection.

The cost per home of curbside service using the Barrel Snatcher was $4.14. The high operating cost, container amortization and low rate of collection made the Barrel Snatcher far less economical for curbside service than the Litter Pig. However, the Barrel Snatcher provides valuable back up when the Litter Pig is out of service.

Our analysis of curb collection shows that the Litter Pig demonstrates a low cost per home per month. For cities interested in taking advantage of lower manpower costs and improved sanitary conditions resulting from containerization of refuse in 80-gallon containers, the Litter Pig is a collection system worth investigating.

The picture for mechanization is quite different in our analysis of alley collection by Godzilla and the Barrel Snatcher. Instead of serving one home per container pick up, these two mechanized vehicles serve an average of 3.3 homes per container pick up.

Godzilla, which could serve 58 homes per hour at the curb, served 160 homes per hour from the 300-gallon containers in the alley. The cost per home per month is $1.82, including $.36 for amortization of the $90.00 - 300-gallon container among 3.3 homes.

The Barrel Snatcher is even more productive. It can serve an average of 271 homes per hour in the alley compared to 61 at the curb. Applying this data to the formula along with the vehicle's high capacity of 357 homes per load, the cost per home per month is $1.53 including amortization of the container.

In terms of economics and productivity, Godzilla and the Barrel Snatcher can serve the average household with alley collection for less than one half the cost of service for the rear end loader. In addition to these savings, the citizen is given an attractive container, his alley is cleaner, and his waste is collected by a higher skilled, higher paid collector worker in a safer and more pleasant working environment. These factors combine to make the mechanization of alley collection, and we expect in the near future to include curb collection, an attractive alternative for municipalities whose waste collection expenditures are surpassing revenues at an ever-increasing rate.

Trash Hog

During Phase II we intended to place in the field one tractor and two transfer trailers and study the economics of their use. The manufacturer was unable, however, to deliver the second trailer for Phase II so our experience is based upon the use of one tractor with one trailer.

To implement our transfer trailer program, a standard tractor was purchased along with a transfer trailer. The tractor cost $16,500 and the expecially designed trailer $23,000. Both were purchased from the Western Body and Hoist Company, Los Angeles. Transfer mechanisms were installed on one Barrel Snatcher and the Litter Pig.

Capacity

The transfer trailer has a capacity of approximately 1200 homes per load depending on the day of the week and the combinations of trucks transferring into it. It can hold three loads from the Barrel Snatcher, six loads from the Litter Pig or combinations of loads from both trucks. The tractor and trailer weigh 51,300 pounds and carry average loads of 18,500 pounds.

Transfer Time

The Barrel Snatcher and Litter Pig require an average of eleven minutes to transfer their loads into the transfer trailer. The operator must back up to the trailer, engage the hooks, attach the hydraulic hoses, open the doors, push the load into the trailer, close the doors, disengage the hoses and return to the cab of the collection vehicle. The average time required to transfer is slightly longer than the average time spent by collection trucks dumping at the landfill as more actions are needed to accomplish a transfer. As the drivers become more proficient, we expect the transfer to reduce to five minutes and the time away from the route to 11 minutes.

Haul Time

We found that the time required to deliver a trailer to the landfill, eject the trailer's load and return it to the transfer location is approximately the same time that the Barrel Snatcher and Litter Pig can leave their route, dump at the landfill and return to their route. Although the trailer is long and difficult to move through residential streets, transfer locations have been selected on major arterials using curbside parking, parking lots or other relatively level areas.

Time Away From Route

The Barrel Snatcher and Litter Pig average 30 minutes away from their routes for load disposal at the landfill. Utilizing the transfer trailer, their time away from their route is reduced one half to 15 minutes. The experiment with the Trash Hog, however, was conducted in the southern section of the city near the landfill. This 15 minute savings by use of the trailer could be as much as 25 to 30 minutes in the northern sections of Scottsdale. When the second transfer trailer is delivered, it will be located to serve the northern collection routes. We expect to reduce the time away from the route to 11 minutes as drivers become more proficient in the transfer process.

Economics

The economics of the use of the Trash Hog are not favorable when it is employed on a part-time basis with short haul distances as it presently is in Scottsdale. The time saved by its use is not enough to offset the cost of purchase and operation. An operator or supervisor must be taken away from his regular job to drive the full trailer to the landfill and return it to the transfer location.

When three trailers are in use and the tractor and driver are employed full time to haul trailers back and forth from the landfill, the picture is different. Below we have made an analysis based upon this situation.

Estimated Cost of Operation

The purchase cost of our system using the cost of the tractor and trailers purchased for Phase II are as follows:

Tractors	$ 16,500
Trailers (3)	69,000
Collection Truck Tailgate Kits (5)	25,000
3 Year Financing @ 10%	11,000
Total Purchase Expense	$121,500

Operating Cost/Month

Amortizing the purchase cost of the tractor, trailers, tailgate kits and financing over seven years with no resale value, the monthly cost would be

$1,446. The Trash Hog is normally operated by an Equipment Operator III who makes $1,030 per month including fringe benefits. Adding to these expenses $309 for administration and overhead and $700 per month for operation and maintenance of the equipment, the total cost of operation per month is $3,485.

The comparative cost of truck haul and transfer system is shown in Table 11.

TABLE 11
COST PER HOME PER MONTH
TRANSFER SYSTEM

	BARREL SNATCHER 300 Gallon	LITTER PIG 80 Gallon
For 1 Hour Haul		
Trucks Hauling	1.53	2.25
Transfer System	1.26	1.71
For 2 Hour Haul		
Trucks Hauling	2.04	2.74
Transfer System	1.41	1.86
For 3 Hour Haul		
Trucks Hauling	2.55	3.23
Transfer System	1.56	2.01
For 4 Hour Haul		
Trucks Hauling	3.05	3.72
Transfer System	1.71	2.15

Cost per home per month includes container amortization.

Maximum Number of Homes Served

The number of homes the transfer system can serve in a day's operation depends on the generating characteristics of the service area and on the time required to travel to the landfill. Below are the maximum number of homes that the system can serve for different times required for the round trip to the landfill and assuming that the tractor is in continuous operation ten hours per day with a capacity load each trip.

Time Required for Round Trip to Landfill (Hours)	Maximum Number of Homes Served
1	24,000
2	12,000
3	8,000
4	6,000

Cost Per Home/Month

Using the monthly operating cost of $3,485, the cost per home per month can be determined by dividing the monthly cost by the number of homes served. For a one hour round trip to the landfill, the cost per month per home for twice-per-week pick up would be $\frac{\$3,485}{24,000}$ or $.15 per home per month.

By applying the formula previously discussed for the collection trucks and using 11 minutes for the time a collection vehicle will take to haul, transfer to the trailer and return, we can compute the cost of collection. The cost of the transfer system is then added to arrive at the total cost.

For alley collection by the Barrel Snatcher, the cost per home per month is $1.11 plus the cost of the transfer system. If the haul time is one hour, the cost per home per month is $.15 plus $1.11 or $1.26. Without the transfer system the cost would be $1.53. The use of the transfer system thus has the potential of saving $.27 per home per month by returning trucks to their collection routes sooner and combining loads in a trailer for hauling to the landfill. Table 11 shows the cost per home per month with and without the transfer system. Note the increase in savings as haul distances and time increase.

Since three trailers can serve 18,000 to 22,000 homes, we would presently be operating a transfer system with excess capacity. Within the next two years, the number of households in Scottsdale will approach 20,000 and the haul time will increase to 45 to 60 minutes as these households are constructed in the northern parts of the city farther from the landfill. At this point, Scottsdale will then be able to take full advantage of the transfer system which worked so successfully in this demonstration project.

Conclusions

Mechanization of residential single family refuse collection as demonstrated in this experiment has tremendous potential in terms of saving tax dollars for municipalities and increasing profits for private collectors. The most successful member of the mechanized family proved to be the Barrel Snatcher in alley collection. Serving the 300-gallon polyethylene containers, this impressive vehicle has a capacity of 357 homes per load and can serve 271 homes per hour of collection. The high monthly operating cost of $3,455 is more than offset by its high performance. The cost per home per month is only $1.53, including container amortization, less than one half the cost of providing service with a rear end loader.

The Litter Pig with the modified telescoping arm side loader proved to be the most productive, least expensive curbside service. Utilizing the 80-gallon polyethylene container, the Litter Pig collected 127 homes per hour at a cost of $2.25 per home per month for twice-a-week service.

The Trash Hog transfer system demonstrated its capabilities in Phase II.

The trailer can serve 1,200 homes in one load and requires collection trucks to be away from their routes fifteen instead of thirty minutes. We expect to reduce this time to about 11 minutes. One tractor and three trailers can serve a community of 20,000 households with the Barrel Snatcher in alley collection for approximately $1.30 per home per month. This represents a savings of $.23 per home per month in spite of the added expense of purchasing a tractor and three trailers and employing a driver. Although it is not presently economical for Scottsdale to use the Trash Hog, by the time the third transfer trailer is purchased, the city will be in a position to take full advantage of the system.

APPENDIX A

SPECIAL PURPOSE REFUSE CONTAINERS

GENERAL INTENTION & SPECIFICATIONS

The general intent is to obtain containers for a new mechanized system for handling containerized family refuse. Bidders are encouraged to participate in the program by offering containers which can be used advantageously It is proposed to load the containers with mechanical loaders which will grip the round containers around part of its circumference. Reinforcing, is, therefore, required. The City proposed to add any local fabrication and modification costs as well as maintenance costs to the bid price and to award the contract to the supplier or suppliers for whom the total cost is least. It is desirable that the containers be shaped with a conical section to permit nesting and convenient emptying and that they have a thickened, reinforced rim or an offset approximately a foot from the top to resist lateral buckling from the lifting device. It is also required that the containers be furnished with a tight hinged lid.

Insofar as they apply, all containers shall comply with the minimum standards of the National Sanitation Foundation Standard No. 21 relating to plastic refuse containers. Requirements with regard to fitting of lids will be waived, since lids must be hinged, and must open by gravity for dumping.

Containers shall be manufactured by the rotational molding method from high density polyethylene or an alternate plastic specified and proven by the supplier, containing a UVR inhibiter guaranteed effective or from other suitable materials, using suitable fabrication techniques, which shall be approved by the City after trials with sample containers.

The containers shall be manufactured with surfaces typically obtained by the rotational molding process using materials conforming to a sample submitted with the bid.

Containers shall be provided in a color required by the City. Each bidder shall submit a set of color cards or other indication of colors available with the bid. The City prefers the green avocado shade presently in use.

Containers shall be fabricated from a cylindrical or conical shape with the bottom smaller, and shall empty across smooth surfaces free of any lips, indentations, projections or other obstructions to the smooth flow of refuse from the container. Scottsdale will approve the container design prior to fabrication.

Containers shall conform to the dimension limits specified by Scottsdale. Due to the nesting construction of the containers, half of the hinge will be applied to the cover and one half to the container, using rivets or bolts with final application of inserting connecting hinge rod to be done at the destination by City. As an alternative, lids and hinges may be pre-assembled and furnished ready to attach to the container.

The City has worked out the container and mechanization system working with Government Innovators of 8201 East Monterey Way, Scottsdale. The City understands that the Company owns patents which cover the containers. Although no royalties would be required for any deliveries to Scottsdale, a license and royalties for other users are required by the Company. Bidders shall make their own arrangements with the Company and shall hold the City harmless from any liability for patent infringements in the use of their containers.

The City expects delivery to be completed within 120 days after award of the bid. Any variance from this requirement should be stated and will be a consideration in the award. Payments will be made monthly for containers delivered during the preceding month.

The containers must be designed to meet the following requirements:

a) 80-gallon containers shall be furnished complete with 8" x 1½" or larger semi-pneumatic wheels with axle and attaching means and shall be designed to be conveniently moved by the user.

Container shall be designed to be stable, loaded or unloaded, with a portion of its weight supported by wheels. They shall also be furnished with a handle to accommodate moving. Handle shall be fabricated to expose only plastic surfaces to the hands of the user.

b) Lids shall be curved or built up to drain, and shall be light and stiff for convenient handling.

c) Lids shall overlap sides, but shall flare out so they will not bind against sides when the container is distorted by the gripping means.

d) Lids shall be fastened to containers and shall be hinged to open by gravity as the container is dumped.

e) Containers shall be designed to regularly receive and dump 500 lbs. in the case of 80 and 1000 lbs. in the case of 300 gallon containers.

f) Containers shall be designed to be picked up and dumped by a gripping device that applies 200 lbs. radial force at a point one-third the height below the top edge of the container. The container shall be designed with an offset at about that point which shall reinforce the container against buckling under the radial gripping load and shall serve as a lifting shoulder to keep the container from falling out of the gripping device.

g) Containers shall be round in horizontal section in the area of the gripping device and capable of being lifted and dumped from any angle.

h) Containers shall function normally and regularly with the City's mechanized collection system.

GUARANTEE - Each bidder shall guarantee his containers from failure in normal and regular use in Scottsdale. The City will replace any containers damaged through negligence or abusive use. Any other containers which fail by reason of improper or inadequate materials or defective workmanship, or insufficient resistance to weathering or for any cause other than negligent or abusive use shall be replaced by the bidder. During the first year from the date of delivery he shall replace all such containers. Each bidder shall state in his bid the period of time during which he guarantees his containers. This period will be an important consideration in evaluation of bids. During the second year, and during subsequent years up to the time of the guarantee, the bidder shall replace a proportionate share of any containers which fail according to the following formula:

$$\text{No. replaced by bidder} = \text{No. failed} \times \frac{\text{Remaining yrs. in guarantee}}{\text{Years Guaranteed}}$$

Thus, if 10 containers failed during the third year of a 5-year guarantee, the bidder would replace 10 X 3/5 or 6 containers, if during the last, or 5th year, 10 X 1/5 or two containers, etc.

Containers which fail during the year shall be accumulated by the City and replaced by order in convenient lots from the bidder. The bidder may, at his convenience, inspect any such containers and may challenge his obligation to replace the container on the basis that the failure resulted from negligent handling or abusive use. If such is the case, then the bidder shall not be required to replace any such containers. If the City and the bidder disagree regarding the reason for failure, then they shall select a third party skilled in the use and fabrication of the materials involved and shall ask his determination on the source of the failure. His determination shall be binding on both parties and they shall abide by it.

The successful bidder shall provide a performance bond in the total amount of the bid for the period of time in the guarantee which shall assure the City of the faithful performance of requirements of these specifications. The bond shall be approved and accepted by the City prior to delivery.

APPENDIX B

SPECIFICATIONS

BARREL SNATCHER

One each front-end loading compactor type collection unit: Complete and ready for regular and normal use in the City's mechanized collection system.

Front-end loader 1,000 pound capacity of the lifting arm to accommodate 80 and 300 gallon containers furnished. Controls shall be one-hand operated and the loader capable of picking up containers centered 12 feet from the truck and dumping them with a maximum cycle time of 15 seconds. The loading mechanism will pick up loads in a segment of 140 degrees from straight out on the right side to 50 degrees left of center line, and shall be equipped with limit switches to prevent spurious dumping. Hydraulic system shall be operated by damped or featherable solenoid controls.

Bulk-head type compactor with thrust ejection.

Hydraulic Compactor with 85,000 pounds thrust, minimum.

Body construction to be of high tensile steel. Body top to be a minimum of 12 gauge steel. Side walls above guide rails, 12 gauge nubunyn steel. Bottom floor plate and side walls 10 gauge steel. Body to be sufficiently supported with steel cross members to assure long life and prevention of sagging, buckling or perforation of floor plate due to constant dumping of containers and unnecessary wear due to compaction action.

Equipped with cab controls, manual or mechanical operated tailgate opener.

Hopper cover which will compress the load under it, and which will open to form a windbreak and chute to guide material into the hopper.

Light to illuminate the packer plate.

Hydraulic system equipped so that loader may be operated from either auxiliary engine or power take-off.

Limiting valve or device to prevent dumping into hopper unless the packer plate is fully retracted.

Ejection and Transfer System

The ejection system shall be capable of ejecting material from the storage body into the special transfer trailer or at the disposal site and of pushing material against the ejection plate at the opposite end of the trailer. The vehicle will also be equipped with a transfer system that will permit the operator to link with a special trailer, raise the tailgates of both the trailer and the vehicle, and transfer material from the collection vehicle to the trailer without requiring assistance and without requiring the operator to leave the cab of the collection vehicle.

Tailgate shall be operated by minimum of 5" hydraulic cylinder and dual chain drive for each direction.

Auxiliary Diesel Engine

Four cylinder four cycle minimum 236 cu. in. Perkins preferred. Min. continuous H.P. 65 @ 2250 Min. intermittent H.P. 78 @ 2500.

Oil Filter

Manufacturer's standard full flow engine to be equipped with direct reading oil pressure and water temperature gauges mounted at engine.

Air Filter

United tri-phase - 1 size larger than air filter manufacturer recommends.

Cooling

Maximum size coolant capacity and fan. Fan to be shrouded if needed.

Throttle Control

Air cylinder actuated by electric - air solenoid valve. All starting, stopping and throttle speed shall be controlled from cab.

Engine Speed

Maximum engine speed to be set to pump manufacturers recommend operating R.P.M.

Fuel

Fuel to be drawn from main engine fuel tank. (No separate tank). Fuel filters as recommended by engine manufacturer.

All equipment called for in this bid shall carry six months or 1000 hour factory guarantee, whichever occurs first, of maintenance free operation (excluding normal preventive maintenance) excepting confirmed negligence on part of user. All gauges, hardware and fabrication to be manufacturer's standard, unless otherwise specified.

Truck & Chassis Specs

G.V.W.	36,000 lbs.
W.B.	140 inches

Engine

Caterpillar, Model 1150 or approved equal.
200 H.P. @ 3000 R.P.M.
Full flow oil filter with replaceable paper element.
Model 750 luberfiner auxiliary by-pass oil filter.
United tri-phase or Donaldson spin type air cleaner with automatic dirt ejector.

Cooling

Manufacturers maximum cooling system guaranteed to under all operating conditions in ambient temperatures of 120 degrees.

Perry water conditioner, with throw-away element, or equal.

Fuel Tank

60 gallon safety tank.

Transmission

Allison M.T. 41 Automatic matched to engine. Engineered to maximum operating speed of 60 M.P.H. Hayden transmission, cooler mounted in front of radiator in direct fan air travel. Transmission cooler not to be connected into radiator.

Drive Lines

Heavy duty for landfill operations.

Front Axle

Timken FL 901,18,000 lb.,wide track. Extra heavy duty shock absorbers.

Front Spring

Adequate for 18,000 lb. axle and loading.

Rear Axle

Timken L100 wide track, or equal. 18,500 lb. minimum 7.0 to 1 or slower ratio. Warn Industries safety bell mounted on right side rear axle.

Tires & Wheels

15 X 22.5 - 16 ply premium nylon tires on front. 18 X 19.5 premium nylon tires on rear. All mounted on 10 hole disc wheels. One of each size, spare front and rear tire and wheel to be furnished with each vehicle.

Steering

Hydraulic power assist, with pump driver, independently from water pump or fan.

Brakes

Full air with the largest size linings and drums available. 12 C.F.M. Compressor. Hand control to actuate brakes on all wheels. Piggy back safety brake with auximilary air tank and cab controls for emergency release of safety brakes. No drive line parking brake, Aeroquip type hose on all air lines. No copper tubing.

Electrical

12 volt, 65 amp alternator, minimum. Delcotron, Autolite, Motorola or Pristolite only. Leece Neville not acceptable. Four (4) 6 volt group 4 batteries. NO EXCEPTIONS. Transistorized voltage regulator. Electric or air windshield wiper. Hobbs hour meter mounted in dash. Engine oil temperature gauge mounted in dash. Fresh air heater and defroster. Dual electric horns. Complete turn and hazard signal system. I.C.C. Cab, Clearance and Tail Lights. Kysor automatic high coolant temperature and low oil pressure cutoff controls with warning bell and light. Mechanex Corporation Electronic speedometer and electronic tachometer.

Mirrors

"Retract" type 6 X 16 mounted each side of front of truck.

Tow Hooks

Front only.

Cab

All steel - one (1) man cab. Sun visor. Roof mounted air horn - SAE & CAA approved safety belt. Premium drivers seat. Tinted glass all around. Single throttle and brake controls (dual controls not mandatory).

Air Conditioning

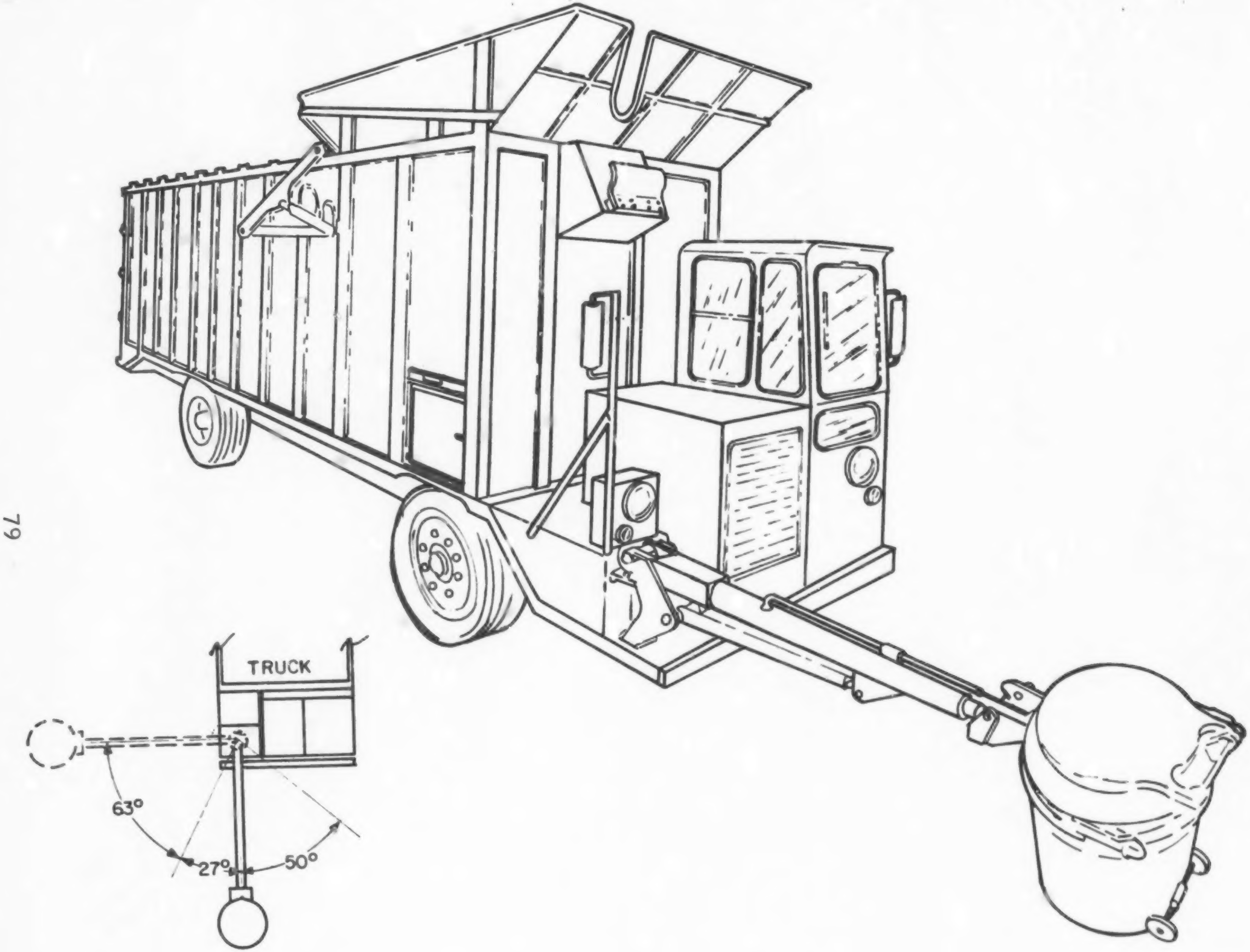
Frigid King - Mark IV or equal.

Paint

DuPont Fawn Beige #4854D or closest beige color.

General

Unit and all components shall meet all applicable federal regulations.


TRUCK
63°
27°
50°

APPENDIX C

CITY OF SCOTTSDALE, ARIZONA

Dear Citizen of Scottsdale:

Your home is part of one neighborhood area selected for an experimental program to improve refuse collection practice. Scottsdale is working with the Office of Solid Waste Management Environmental Protection Agency on a series of experiments to determine the feasibility of mechanizing the refuse collection process. Our first phase objective, which we are asking you to help with will be to determine public acceptance of the basic requirement that refuse be contained in standard containers in order to implement the mechanization. Later experiments will determine the best mechanization technique, the economics of the program and other considerations. We must first determine public response to containerization.

The first phase will involve the use of standard containers. Most participating households will be asked to share a container which will be furnished by the city for the six month duration of the experiment. We have done some preliminary work to determine the best size and have selected containers which we are confident will be large enough for any normal waste accumulation. We have mounted on a refuse truck a crude lift mechanism which has a lifting limit of 500 lbs. and we must ask that you limit the weight of each load to 500 lbs. With that limit in mind, however, you may put containers of extra material on the lid to be dumped with the containers. Containers are polyethylene plastic, which is tough, durable, long-lived, and the most attractive and suitable material we have found. They will be furnished with lids which must be closed to protect against flies. They have been designed to resist access by animals, to be convenient for you and your family to use, and to be utilitarian, as well as easy for our equipment to handle.

We will be working closely with the County Health Department to study and control the sanitation aspects of our containerization work. We expect to treat the containers periodically to eliminate insects and will study other ways to improve the sanitation of the containers.

We plan to serve your home for approximately six months with these special containers. At the end of that time we will conduct another survey to determine how the containers have worked in use and then will decide whether or not to proceed with further phases of the work.

Now, we need your help. We encourage you to contact us if you have any suggestions.

Your home will be served with the following service:

Size of Container ____________
Pickups per week ____________
Total Households Using Container ________

Note that containers must be pointed toward the truck to be picked up properly. Please don't relocate your container without contacting us. If your container has casters, we have painted an arrowhead on your curb to help you set your container for us. Please call me for further information or to discuss our proposal, at 994-2415.

Department of Public Works

APPENDIX D

SURVEY FORM TO EVALUATE REACTION TO MECHANIZED COLLECTION SYSTEM

INTERVIEW NO. _______

SCOTTSDALE REFUSE CONTAINERIZATION EVALUATION
(CONFIDENTIAL)

ADDRESS: ________________________________

INTERVIEWER: ________________________________

CALLS: ________________________________

____

____

____

1. SAMPLE NUMBER: ____________

2. PICKUP:

   1. Alley
   2. Curb

3. CONTAINER SIZE: ____________

4. CONTAINER:

   1. Individual
   2 Collective

5. DWELLING UNIT:

   1. House or Duplex

   2. Apartment or Flat

   3. Rooming House

   4. Other (specify) ____________________

PRETEST INTERVIEW

INTRODUCTION:

A. "Hello, I'm ______________________ representing the City of Scottsdale.
B. As you may have heard, the City of Scottsdale is going to try a new system of refuse collection. By refuse collection, we mean the normal garbage and trash which you dispose of.
C. We want to find out your opinions about present refuse collection service.
D. I'm going to read a few statements, and I would like to know if you strongly agree with them, agree with them, disagree, or strongly disagree with them."

(SHOW CARD)

CIRCLE CORRECT ANSWER:

		Strongly Agree	Agree	Disagree	Strongly Disagree
6.	First, the city is doing an excellent job of collecting refuse.	4	3	2	1
7.	The city could do a better job of collecting refuse than it is presently doing.	4	3	2	1
*8.	I would not be willing to try a more mechanized way of collecting refuse.	4	3	2	1
9.	Using more machines in collecting refuse would probably result in better service.	4	3	2	1
10.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				
*11.	The people who collect the refuse are doing a poor job.	4	3	2	1
12.	I could use more refuse container capacity than I presently have.	4	3	2	1
13.	I would not mind using a container which is owned by the city.	4	3	2	1
14.	Collecting refuse by hand rather than by machine probably costs more money.	4	3	2	1
*15.	Collecting refuse by hand rather than by machine probably is faster.	4	3	2	1
*16.	I would not share a refuse container with a neighbor even if it is big enough.	4	3	2	1
17.	Refuse is collected just about often enough for me.	4	3	2	1

	Strongly Agree	Agree	Disagree	Strongly Disagree
18. The city employees collecting the refuse are doing a good job.	4	3	2	1
19. The refuse cans are usually replaced properly.	4	3	2	1
20. XXXXXXXXXXXXXXXXXXXXXXXXXXXXX				
21. The container covers are usually placed back on the cans after emptying.	4	3	2	1
22. The area where the refuse containers are placed smells pretty bad.	4	3	2	1
23. It's easy to keep all the refuse in the cans so it will not make the area messy.	4	3	2	1

Now I would like to ask you for your comments on a few questions.

24. What do you like most about the way refuse is presently being collected?

Write in verbatim

Anything else?

25. What do you dislike most about the way refuse is presently being collected?

Write in verbatim

Anything else?

26. How do you think the city could improve its collection of refuse?

____

Write in verbatim

____

27. How many refuse containers do you presently use?

One	1
Two	2
Three	3
Four or more	4

28. How well would you say you like the way refuse is being collected?

Dislike it very much	1
Dislike it somewhat	2
Indifferent	3
Like it somewhat	4
Like it very well	5

29. How long have you lived in this house?

Less than 6 months	1
6 months to 1 year	2
1 to 2 years	3
3 to 5 years	4
5 to 10 years	5
over 10 years	6

30. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

31. What is your telephone number? ____________________

32. Time ____________ Day of Week ____________ Date ________________

Thank you very much for your cooperation.

POST TEST INTERVIEW SCHEDULE

33. Respondent

Same as Pretest	1
Different but same household	2
Different household	3

34. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

INTRODUCTION:

A. "Hello, I'm ______________________________ representing the City of Scottsdale.

B. You may recall that I talked with you (or someone in this house) about the new way we are trying to contain and collect refuse.

C. I would like to ask you your opinion about how the new system works.

35. First, what do you like most about the way refuse is contained in the new cans?

____
Write in verbatim

Anything else?

____

36. What do you dislike most about the way refuse is contained in the new cans?

____
Write in verbatim

Anything else?

____

37. What do you like most about the new way refuse is being collected?

____
Write in verbatim

Anything else?

____

38. What do you dislike most about the new way refuse is being collected?

Write in verbatim

Anything else?

39. Do you think the city should stay with the old way or the new way of collecting refuse?

Old way	1
New way	2
Don't know	3

40. How well would you say you like the new way of refuse collection?

Dislike it very much	1
Dislike it somewhat	2
Indifferent	3
Like it somewhat	4
Like it very well	5

41. How do you think the city could improve on the new way of collecting refuse?

Write in verbatim

Anything else?

INSTRUCTIONS:

Now, I will need a few statements and I would like to know if you strongly agree with them, agree, disagree, or strongly disagree with them. (SHOW CARD)

		Strongly Agree	Agree	Disagree	Strongly Disagree
42.	The city is doing an excellent job of collecting the refuse.	4	3	2	1
43.	The city could do a better job of collecting refuse than it is presently doing.	4	3	2	1
*44.	I would not be willing to continue the new way of collecting refuse.	4	3	2	1
45.	Using more machines in collecting refuse would probably result in better service.	4	3	2	1
46.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				
*47.	The people who collect the refuse are doing a poor job.	4	3	2	1
48.	I could use more refuse container capacity than I presently have.	4	3	2	1
49.	I do not mind using a container which is owned by the city.	4	3	2	1
50.	Collecting refuse by hand rather than by machine costs more money.	4	3	2	1
*51.	Collecting refuse by hand rather than by machine probably is faster.	4	3	2	1
*52.	I will not share a refuse container with a neighbor even if it is big enough.	4	3	2	1
53.	Refuse is now collected just about often enough for me.	4	3	2	1
54.	The city employees collecting the refuse are doing a good job.	4	3	2	1
55.	The refuse cans are usually replaced properly now.	4	3	2	1

		Strongly Agree	Agree	Disagree	Strongly Disagree
56.	XXXXXXXXXXXXXXXXXXXXXXXXXXX				
57.	The container covers are usually placed back on the cans after emptying.	4	3	2	1
58.	The area where the refuse cans are placed smells pretty bad.	4	3	2	1
59.	It's easy to keep all the refuse cans so it will not make the area messy.	4	3	2	1
60.	Dogs and cats are getting in the cans a lot now.	4	3	2	1

Thank you very much for your cooperation.

* These questions were asterisked to provide information on negative feelings toward the system. Used for statistical computation only.

XXXXXXXXX Used for keypunch purposes in computer program.

APPENDIX E

RESIDENT ATTITUDES
TOWARD
SCOTTSDALE REFUSE
CONTAINERIZATION EXPERIMENT

Dr. Dickinson L. McGaw
Director, Survey Research Center
Political Science Department
Arizona State University
Tempe, Arizona

THE PROBLEM

The evaluation of the success of the containerization experiment depends partly upon resident attitudes toward the system. To what extent will the residents comply with a change in the system of refuse collection? Will residents mind sharing containers with their neighbors? Is larger containers capacity wanted or is more frequent pickup desired? Are odors reduced? These are some of many questions an evaluator must answer to identify system weaknesses for improvement.

METHOD

Five areas of the City were selected as experimental areas. Randon selection of household units was not feasible due to collection costs. The areas selected represented middle-middle class and lower-middle class residential areas in the City.

Three employees trained at interviewing conducted before and after interviews with mature residents in each of the selected households. An Administrative Assistant introduced the system by thorough explanation after the interview. A written explanation was left with each resident (Appendix C).

More than 500 homes were used in the experiment. Only 259 were used in the statistical analysis due to difficulty of obtaining a complete before or after interview from the same resident.

The interview schedule contained structured and open-ended questions. It took approximately 10-15 minutes for completion. The interview scheduled is contained in Appendix D. Questions 1-32 were used for the pretest and questions 39-74, the posttest.

Four independent variables were used in this study: (1) Container size; (2) Container ventilation; (3) Pickup frequency; and (4) Number of homes sharing the container. Eight treatments were applied:

	Container Size	Pickups/Week	No. Homes	Ventilation	Total Homes
1.	80 gal.	2	1	Yes	34
2.	80 gal.	2	1	No	21
3.	160 gal.	1	1	Yes	23
4.	160 gal.	1	1	No	22
5.	160 gal.	2	2	Yes	60
6.	300 gal.	1	2	Yes	26
7.	300 gal.	1	2	No	17
8.	300 gal.	2	4	Yes	56
				TOTAL HOMES	259

RESULTS

The 259 observations are analyzed in the eight treatment groups mentioned in the previous section and together as a group. A difference of proportions test is applied to the test for statistical significance. We test the null hypothesis $Ho:P_1 = P_2$. The level set for achieving statistical significance is .05. The formula used for the test is:

$$P = \frac{n_1 \; p_1 + n_2 \, p_2}{n_1 + n_2}$$

$$Z = \frac{p_1 - p_2}{\sqrt{PQ(1/n_1 + 1/n_2)}}$$

The first item included in the test (Table E-1) is, "The City is doing an excellent job of collecting refuse." Percent agreement increases in all treatment groups and the total sample. Statistical significance is not achieved, however, in the seventh treatment group. Sixty percent in the before test agreed with this item, while ninety-four percent agreed after the completion of the experiment. Treatments 2, 3, and 4, yielded 100% agreement in the post-test.

The second item concerns whether the City could do a better job of collecting refuse than it is presently doing. If the experiment was effective, then we would predict lower percentage agreement on the post-test than on the pretest. Again all of the treatment's effects point in the predicted direction. Only treatment seven lacks statistical significance. 67% of the whole sample agreed with the item on the before test and 30% agreed on the after test (Table E-2).

How many residents would not be willing to try a more mechanized method of refuse collection? Table E-3 indicates that fewer residents are willing to agree with this statement after the experiment than before, thus indicating acceptance of the method introduced. Treatments 3, 5, 6, and 7 were pointed in the predicted direction, but failed to achieve statistical significance.

In Table E-4 we ask: "Using more machines in collecting refuse would probably result in better service." Many residents did not feel qualified to answer this auestion and did not respond. The only treatment reaching significance was number five.

Several items are worded such that a person who has a high positive attitude toward the experiment must say "no" to several questions. This technique is used to control for response set.

In other words, many people are psychologically predisposed to say either "yes" or "no" to almost any kind of question. By reversing the direction of the question (i.e., from "The program was great" where a positive score would be a "yes" answer to "The program was a failure" where a success score for experiment would be "no"), we can identify persons who are susceptible to the response set tendency and analyze them separately.

All treatments except number six achieved significance with a one-tailed test.

The residents were asked to suggest how the new containerization method could be improved. Table E-5 demonstrates some satisfaction with slightly more than half not responding. The most frequent suggestion was to make more durable containers (10%). The second most frequent suggestion was to increase the frequency of pickups.

What did Scottsdale residents dislike most about the old and new systems of refuse collection? Table E-6 indicates that complaints against the old system were: 31%, poor collection, containers, and messy alleys; 13%, small containers; 7%, infrequent collection of boxes and branches; 14%, irregular pickups; and 4%, noise.

In Table E-7 we discover what residents dislike most about the new system. The most frequent complaint was inadequate capacity (14%); second was the inconvenience of greater walking and the difficulty children have in lifting lids. The third most frequent complaint was neighbor sharing which was tied with poor containers and messy alleys.

We asked before the experiment began how the old system could be improved. Table E-8 shows that 16% of the residents thought mechanization might help; 10% favored more frequent pickups; 9% favored more careful collection; and 5% wanted better workers with more pay.

In Table E-9 we examine whether refuse could be kept in containers to keep the area from being messy. In each treatment category we find a significant increase in satisfaction in the post-test from the pretest in maintaining a clean refuse containment area.

Residents were asked what they liked most about the old system (pretest) and the new system (post-test) of refuse collection. For the whole sample of the pretest (Table E-10), 42% liked regular and frequent collection most, while others expressed diffuse satisfaction with the old system. In the post-test, residents were more specific about what they liked about the experiment. 32% mentioned adequate capacity; 21%, a cleaner alley; and 12%, containers stay covered and do not tip over (Table E-11). In treatments 1 and 2 the ability to move containers were frequent responses.

Did the experiment affect attitudes toward frequency of collection? Table E-12 indicates a tendency for the experiment to alleviate demands for more frequent collection.

Are City employees collecting refuse perceived as doing a good job? Before the experiment began, 55% thought refuse collectors were doing a good job; but after the experiment 96% thought the employees were doing a good job (Table E-13).

The experiment shows dramatic results concerning replacement of refuse cans (Table E-14). In all cases the experiment improved the attitudes toward the system. In the total sample 55% agreed with the statement in the pretest, but 96% agreed in the post-test. Explanation: agreed refers to adding both the "strongly agree" and "agree" categories.

A frequent complaint of the old system was the failure to replace container covers. 73% of the sample was dissatisfied with cover replacement. With the introduction of the experiment, however, only 3% expressed dissatisfaction with cover replacement (Table E-15).

In Table E-16 we examine whether the experiment minimized the odors around the containers. The data are inconsistent among the various treatments. The whole sample results indicate improvement after the introduction of the experiment.

In Table E-17, the question stated is: "I could use more refuse container capacity than I presently have." Fifty percent of the total group agreed in the pretest but only thirty-four percent in the post-test wanted more container capacity. Treatments five and eight demonstrated strongest need for more container capacity. People in these treatment areas wanted more container capacity than those persons exposed to the other treatments.

Would residents mind using a container owned by the City? Table E-18 illustrates only 14% in the pretest and 4% in the post-test preferring not to use City containers.

Do citizens perceive a savings through mechanized containerization? Table E-19 indicates that citizens perceive the hand collection method is more costly than the mechanized method of refuse collection. The City may produce more educational information concerning relative costs to gain greater acceptance.

Which is perceived as being faster--collection by hand or collection by machine? Table E-20 indicates that residents do not have consistent attitudes toward time savings in machine collection.

A majority of the respondents tend to feel that machine collection is faster than hand collection.

Would residents be willing to share containers with neighbors? Table E-21 shows that 53% of the sample in the pretest and 78% in the post-test were willing to share containers. The data indicate the residents who have had sharing experiences in the experiment were slightly more likely to accept sharing than those residents who had individual containers.

CONCLUSION

Two-hundred fifty-nine residents were exposed to eight different combinations of collection services:

(1) 80-, 160-, or 300-gallon containers
(2) 1 or 2 times a week pickup
(3) Ventilated or non-ventilated containers and
(4) 1, 2, or 4 homes sharing.

All eight treatments produced statistically significant effects measured by interview responds on before and after tests. Treatment seven showed the weakest relationship of the eight treatments. The major improvements needed as perceived by the residents were more durable containers and more frequent pickups.

TABLE E-1: Before and After Percentage Distributions and Tests of Statistical Significance for:
"The city is doing an excellent job of collecting refuse."

	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	9%	12%	5%	19%	4%	4%	9%	9%	12%	15%	8%	4%	18%	6%	2%	9%	7%	10%
AGREE	41	85	47	81	61	96	41	91	53	77	58	88	59	82	61	84	53	84
DISAGREE	44	3	43	0	26	0	41	0	30	8	34	4	23	12	34	2	35	4
STRONGLY DISAGREE	6	0	5	0	9	0	9	0	5	0	0	0	0	0	3	1	5	2
NO ANSWER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

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* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE BASED ON % AGREEMENT:

Treatment 1: $p < .001$
Treatment 2: $p < .001$
Treatment 3: $p < .001$
Treatment 4: $p < .001$
Treatment 5: $p < .01$
Treatment 6: $p < .01$
Treatment 7: $p < .2$
Treatment 8: $p < .001$
All: $p < .001$

TABLE E-2: Before and After Percentage Distributions and Tests of Statistical Significance for:
"The city could do a better job of collecting refuse than it is presently doing."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	15%	3%	29%	0%	4%	4%	14%	0%	8%	3%	8%	0%	12%	0%	16%	0%	13%	2%
AGREE	56	26	56	24	35	13	64	18	57	42	58	35	47	35	55	21	54	28
DISAGREE	26	65	10	76	57	87	23	82	30	52	35	65	41	65	25	71	30	67
STRONGLY DISAGREE	0	6	0	0	0	0	0	0	3	3	0	0	0	0	2	2	1	2
NO ANSWER	3	0	5	0	4	0	0	0	2	0	0	0	0	0	2	5	2	1
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .001$
Treatment 2: $p < .01$
Treatment 3: $p < .05$
Treatment 4: $p < .001$
Treatment 5: $p < .05$
Treatment 6: $p < .05$
Treatment 7: $p < .08$
Treatment 8: $p < .01$
All: $p < .001$

TABLE E-3: Before and After Percentage Distributions and Tests of Statistical Significance for:
"I would not be willing to try a more mechanized way of collecting refuse."

	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY DISAGREE	18%	18%	19%	10%	0%	9%	5%	9%	17%	17%	4%	4%	6%	35%	16%	11%	12%	13%
DISAGREE	70	79	52	85	57	83	59	86	57	67	77	88	82	59	64	82	64	77
AGREE	12	3	24	5	30	4	32	5	23	13	12	4	12	6	13	4	18	6
STRONGLY AGREE	0	0	5	0	0	4	0	0	2	2	0	0	0	0	0	0	1	1
NO ANSWER	0	0	0	0	13	0	5	0	2	2	7	4	0	0	7	4	5	3
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .05$
Treatment 2: $p < .01$
Treatment 3: $p < .3$
Treatment 4: $p < .01$
Treatment 5: $p < .08$
Treatment 6: $p < .10$
Treatment 7: $p < .3$
Treatment 8: $p < .05$
All: $p < .001$

TABLE E-4: Before and After Percentage Distributions and Tests of Statistical Significance
"Using more machines in collecting refuse would probably result in better service."

RESPONSE	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	3%	6%	19%	10%	4%	0%	0%	0%	7%	2%	0%	0%	0%	0%	9%	5%	5	3
AGREE	55	62	52	66	39	57	73	64	47	67	63	58	76	65	46	52	54	61
DISAGREE	18	26	5	24	43	35	14	36	40	23	19	27	18	29	20	34	24	29
STRONGLY DISAGREE		6	0	0	0	0	0	0	2	3	4	0	0	0	2	0	1	2
NO ANSWER	24	0	14	0	13	9	14	0	5	5	11	15	6	6	23	9	15	5
TOTAL %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .2$
Treatment 2: $p < .4$
Treatment 3: $p < .2$
Treatment 4: $p < .3$
Treatment 5: $p < .05$
Treatment 6: $p < .4$
Treatment 7: $p < .3$
Treatment 8: $p <$ not significant
All: $p < .12$

TABLE E-5: What residents suggested for improving the new method - Post test

MORE FREQUENT PICKUPS	5%
LARGER CAPACITY	8
MORE MEN AND BETTER PAY	1
MAKE LIDS LIGHTER AND EASIER TO LIFT	2
MAKE INDIVIDUAL CANS NO SHARING	3
MAKE MORE DURABLE CONTAINS	10
OTHER	15
NO ANSWER	54
TOTAL	100%
CASES	(259)

TABLE E-6: What residents disliked most about old system.

RESPONSE	%
POOR COLLECTION/CONTAINERS/MESSY ALLEYS	31%
CONTAINERS: TOO SMALL/ FILL UP TOO FAST/ THROWN AROUND	13
NOISE	4
INFREQUENT COLLECTION OF BOXES AND BRANCHES	7
IRREGULAR PICKUPS	14
NOTHING	17
OTHER	5
NO ANSWER	9
TOTAL PERCENT	100%
CASES	(259)

TABLE E-7: What residents disliked most about the system.

RESPONSE	TREATMENT NUMBER								
	1	2	3	4	5	6	7	8	All
Inconvenience: Walking/Children can't use	18%	0%	0%	5%	5%	15%	18%	5%	8%
Inadequate Capacity	9	29	4	9	17	19	0	14	14
Odor	9	0	0	9	5	0	12	2	4
Neighbor Sharing	0	0	9	5	5	8	0	9	5
Infrequent Collection of Boxes & Branches	3	0	4	0	0	4	6	4	2
Messy Alley/ Poor Containers	6	14	4	9	13	12	6	18	5
Heavy Lids	3	0	4	0	2	4	6	0	2
No Answer	44	48	61	55	45	35	53	41	46
Other	9	10	13	9	8	4	0	7	8
TOTAL %	100	100	100	100	100	100	100	100	100
CASES	(34)	(21)	(23)	(22)	(60)	(26)	(17)	(56)	(259)

TABLE E-8: What residents suggested for improving old method - Pretest

MECHANIZATION	16%
CONTAINERS: MORE AND LARGER	3
SATISFIED	5
MORE CAREFUL COLLECTION	9
BETTER MEN AND MORE PAY	5
MORE PICKUPS	10
OTHER	18
NO ANSWER	33
TOTAL PERCENT	100%
CASES	(259)

TABLE E-9: Before and After Percentage Distributions and Tests of Statistical Significance for: "It's easy to keep all the refuse in the cans so it will not make the area messy."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	9%	9%	5%	5%	4%	9%	5%	0%	8%	7%	0%	4%	12%	0%	4%	5%	6	5
AGREE	65	85	48	86	57	91	73	100	52	87	62	92	47	94	52	88	56	89
DISAGREE	26	6	38	5	35	0	18	0	27	7	35	0	35	6	34	7	31	5
STRONGLY DISAGREE	0	0	9	0	4	0	5	0	13	0	4	0	6	0	11	0	8	0
NO ANSWER	0	0	0	5	0	0	0	0	0	0	0	4	0	0	0	0	0	1
TOTAL %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*Difference of Proportions Test of Statistical Significance:

Treatment 1: $p < .01$
Treatment 2: $p < .001$
Treatment 3: $p < .01$
Treatment 4: $p < .05$
Treatment 5: $p < .05$
Treatment 6: $p < .05$
Treatment 7: $p < .05$
Treatment 8: $p < .05$
All: $p < .05$

TABLE E-10: What Residents Liked Most About Old System -- Pretest Answers

RESPONSE	TREATMENT NUMBER								
	1	2	3	4	5	6	7	8	ALL
REGULAR & FREQUENT COLLECTION	26%	29%	35%	32%	55%	62%	35%	43%	42%
LID & CAN REPLACEMENT	0	0	4	5	3	0	12	0	2
SATISFACTION WITH PRESENT SYSTEM	12	14	17	14	13	23	35	5	13
GOOD COLLECTORS	15	10	0	0	3	4	12	2	5
QUIET COLLECTION	0	0	0	5	5	0	12	2	2
NOTHING	15	0	26	32	5	4	0	11	11
OTHER	12	10	0	9	8	0	0	16	8
TOTAL %	100	100	100	100	100	100	100	100	100
CASE	(34)	(21)	(23)	(22)	(60)	(26)	(17)	(56)	(259)

TABLE E-11: What Residents Liked Most about New System -- Post test

RESPONSE	TREATMENT NUMBER								
	1	2	3	4	5	6	7	8	ALL
ADEQUATE CAPACITY	47%	38%	43%	36%	25%	35%	24%	23%	32%
CLEANER ALLEY	12	14	17	27	25	23	6	27	21
CANS COVERED DON'T TIP OVER	9	0	4	13	13	15	29	13	12
EASY TO MOVE	15	19	0	0	0	0	0	0	3
SATISFIED	12	5	35	14	23	4	12	13	15
NOTHING	0	0	0	5	10	8	6	5	5
OTHER	6	24	0	0	3	12	24	12	9
NO ANSWER	0	0	0	5	0	4	0	7	2
TOTAL%	100	100	100	100	100	100	100	100	100
CASE	(34)	(21)	(23)	(22)	(60)	(26)	(17)	(56)	(259)

TABLE E-12: Before and After Percentage Distributions & Tests of Statistical Significance for: "Refuse is collected just about often enough for us."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Strongly Agree	9%	9%	5%	0%	0%	0%	9%	0%	7%	10%	8%	0%	0%	0%	5%	0%	6%	3%
Agree	79	91	71	95	61	91	59	91	67	78	85	77	88	82	82	91	74	86
Disagree	12	0	24	0	22	8	23	9	20	12	8	15	6	18	11	5	15	8
Strongly Disagree	0	0	0	0	17	0	9	0	7	0	0	4	0	0	2	0	4	1
No Answer	0	0	0	5	0	0	0	0	0	0	0	4	6	0	0	4	1	2
TOTAL % CASES	100% (34)	100% (34)	100% (21)	100% (21)	100% (23)	100% (23)	100% (22)	100% (22)	100% (60)	100% (60)	100% (26)	100% (26)	100% (17)	100% (17)	100% (56)	100% (56)	100% (259)	100% (259)

✲ DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1:	$p < .05$
Treatment 2:	$p < .05$
Treatment 3:	$p < .05$
Treatment 4:	$p < .05$
Treatment 5:	$p < .05$
Treatment 6:	$p < .05$
Treatment 7:	Not sig.
Treatment 8:	Not sig.
All:	$p < .001$

TABLE E-13: Before and After Percentage Distributions and Tests of Statistical Significance for: "The city employees collecting the refuse are doing a good job."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Strongly Agree	15%	18%	0%	0%	4%	0%	5%	0%	7%	7%	0%	8%	6%	12%	4%	7%	2%	7%
Agree	65	82	81	100	48	96	64	100	65	92	85	88	82	76	64	84	53	89
Disagree	18	0	14	0	35	4	27	0	25	2	15	4	12	12	23	2	29	2
Strongly Disagree	0	0	0	0	9	0	5	0	3	0	0	0	0	0	5	0	16	0
No Answer	2	0	5	0	4	0	0	0	0	0	0	0	0	0	4	7	0	1
TOTAL % CASES	100% (34)	100% (34)	100% (21)	100% (21)	100% (23)	100% (23)	100% (22)	100% (22)	100% (60)	100% (60)	100% (26)	100% (26)	100% (17)	100% (17)	100% (56)	100% (56)	100% (259)	100% (259)

* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .01$
Treatment 2: $p < .05$
Treatment 3: $p < .001$
Treatment 4: $p < .01$
Treatment 5: $p < .05$
Treatment 6: $p < .06$
Treatment 7: Not Sig.
Treatment 8: $p < .05$
All: $p < .001$

TABLE E-14: Before and After Percentage Distributions and Tests of Statistical Significance for: "The refuse cans are usually replaced properly."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		All	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	9%	9%	0%	5%	9%	0%	0%	0%	3%	5%	0%	0%	0%	0%	2%	0%	2%	3%
AGREE	56	91	57	95	52	100	59	100	52	88	54	96	76	94	43	93	53	93
DISAGREE	29	0	24	0	22	0	32	0	28	3	38	4	24	6	29	5	29	3
STRONGLY DISAGREE	6	0	19	0	26	0	9	0	17	3	8	0	0	0	26	0	16	1
NO ANSWER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .001$
Treatment 2: $p < .001$
Treatment 3: $p < .001$
Treatment 4: $p < .05$
Treatment 5: $p < .05$
Treatment 6: $p < .05$
Treatment 7: $p < .05$
Treatment 8: $p < .001$
All: $p < .001$

TABLE E-15: Before and After Percentage Distributions and Tests of Statistical Significance for; "The container covers are usually placed back on the cans after emptying."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	3%	9%	0%	0%	0%	0%	0%	0%	2%	5%	0%	4%	0%	0%	0%	0%	1%	3%
AGREE	38	91	14	95	30	96	23	91	22	85	15	92	35	100	18	95	24	92
DISAGREE	41	0	38	5	30	4	45	9	50	5	62	0	59	0	43	4	46	3
STRONGLY DISAGREE	15	0	33	0	30	0	32	0	27	2	19	0	6	0	38	0	27	0
NO ANSWER	3	0	14	0	9	0	0	0	0	3	4	4	0	0	2	2	2	2
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .001$
Treatment 2: $p < .001$
Treatment 3: $p < .001$
Treatment 4: $p < .05$
Treatment 5: $p < .001$
Treatment 6: $p < .01$
Treatment 7: $p < .01$
Treatment 8: $p < .001$
All: $p < .001$

TABLE E-16: Before and After Percentage Distributions and Tests of Statistical Significance for: "The area where the refuse containers are placed smells pretty badly."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		All	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	0%	6%	0%	0%	0%	4%	9%	0%	2%	2%	0%	0%	0%	0%	5%	4%	2	2
AGREE	18	18	33	10	22	0	14	14	20	7	12	12	6	18	14	7	17	10
DISAGREE	74	71	48	81	78	91	68	82	70	75	69	85	76	76	64	84	68	80
STRONGLY DISAGREE	8	5	19	9	0	0	9	5	8	15	19	4	12	0	11	5	10	7
NO ANSWER	0	0	0	0	0	4	0	0	0	2	0	0	0	6	5	0	3	1
TOTAL %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .27$
Treatment 2: $p < .05$
Treatment 3: $p < .05$
Treatment 4: $p < .3$
Treatment 5: $p < .05$
Treatment 6: not significant
Treatment 7: $p < .13$
Treatment 8: not significant
All: $p < .01$

TABLE E-17: Before and After Percentage Distributions and Tests of Statistical Significance for: "I could use more refuse container capacity than I presently have."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	9%	6%	29%	5%	9%	9%	14%	9%	12%	10%	0%	8%	18%	0%	0%	5%	10	7
AGREE	56	18	42	24	39	9	18	14	40	32	42	23	47	35	36	41	40	27
DISAGREE	32	65	29	66	52	83	64	77	45	58	54	54	35	59	57	46	47	60
STRONGLY DISAGREE	3	11	0	0	0	0	5	0	3	0	0	0	0	0	0	0	2	2
NO ANSWER	0	0	0	5	0	0	0	0	0	0	4	15	0	6	2	7	1	4
TOTAL %	100	100	100	100	100	180	100	100	100	100	100	100	100	100	100	100	100	100
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .001$
Treatment 2: $p < .01$
Treatment 3: $p < .01$
Treatment 4: $p < .23$
Treatment 5: $p < .15$
Treatment 6: $p < .3$
Treatment 7: $p < .05$
Treatment 8: $p < .05$
All: $p < .01$

TABLE E-18: Before and After Percentage Distributions and Tests of Statistical Significance for: "I would not mind using a container which is owned by the city."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	6%	18%	28%	14%	0%	0%	5%	5%	13%	22%	0%	4%	24%	0%	21%	14%	13	12
AGREE	82	82	62	86	61	100	73	85	70	68	96	92	65	88	73	82	73	83
DISAGREE	12	0	10	0	35	0	18	0	15	7	4	4	12	12	5	2	13	3
STRONGLY DISAGREE	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	1	1
NO ANSWER	0	0	0	0	4	0	5	0	0	0	0	0	0	0	0	2	0	1
TOTAL %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .01$
Treatment 2: $p < .07$
Treatment 3: $p < .05$
Treatment 4: $p < .12$
Treatment 5: not significant
Treatment 6: not significant
Treatment 7: not significant
Treatment 8: not significant
All: $p < .001$

TABLE E-19: Before and After Percentage Distributions and Tests of Statistical Significance for: "Collecting refuse by hand rather than by machine probably costs more money."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY AGREE	3%	0%	19%	10%	0%	0%	0%	0%	2%	3%	4%	0%	6%	6%	11%	2%	5	2
AGREE	47	47	48	28	48	22	68	27	55	40	62	31	35	18	55	45	53	36
DISAGREE	21	21	0	14	22	13	23	23	35	8	15	12	29	12	14	13	21	13
STRONGLY DISAGREE	0	3	0	0	0	0	0	0	2	5	4	0	6	0	0	0	1	2
NO ANSWER	29	29	33	48	30	65	9	50	7	43	15	58	24	65	20	41	19	47
TOTAL %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

*DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: p not significant
Treatment 2: $p < .05$
Treatment 3: $p < .05$
Treatment 4: $p < .05$
Treatment 5: $p < .05$
Treatment 6: $p < .05$
Treatment 7: $p < .05$
Treatment 8: $p < .05$
All: $p < .01$

TABLE E-20: Before and After Percentage Distributions and Tests of Statistical Significance for: "Collecting refuse by hand rather than by machine probably is faster."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY DISAGREE	0%	6%	19%	14%	0%	4%	5%	0%	5%	12%	8%	4%	0%	0%	9%	5%	6%	6%
DISAGREE	38	57	48	62	39	48	50	68	47	58	73	54	65	29	52	61	50	56
AGREE	35	24	14	14	43	17	32	9	38	18	12	15	24	6	16	11	27	15
STRONGLY AGREE	3	0	0	0	0	0	0	0	0	3	0	0	0	0	2	0	1	1
NO ANSWER	24	15	19	0	17	30	14	23	10	8	8	27	12	65	21	23	16	22
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .01$
Treatment 2: $p < .25$
Treatment 3: $p < .2$
Treatment 4: $p < .2$
Treatment 5: $p < .05$
Treatment 6: $p < .05$
Treatment 7: $p < .05$
Treatment 8: not significant
All: $p < .08$

TABLE E-21: Before and After Percentage Distributions and Tests of Statistical Significance for: "I would not share a refuse container with a neighbor even if it is big enough."

RESPONSE	TREATMENT NUMBER																	
	1		2		3		4		5		6		7		8		ALL	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
STRONGLY DISAGREE	9%	0%	5%	0%	4%	0%	9%	0%	5%	13%	4%	8%	12%	12%	13%	9%	8	7
DISAGREE	29	53	24	71	48	70	32	59	45	77	62	69	82	76	52	82	45	71
AGREE	41	12	48	19	48	22	50	32	35	5	31	15	6	12	29	4	36	12
STRONGLY AGREE	21	12	19	4	0	9	9	9	15	5	0	4	0	0	7	2	10	5
NO ANSWER	0	24	5	5	0	0	0	0	0	0	4	4	0	0	0	4	1	5
TOTAL %	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CASES	(34)	(34)	(21)	(21)	(23)	(23)	(22)	(22)	(60)	(60)	(26)	(26)	(17)	(17)	(56)	(56)	(259)	(259)

* DIFFERENCE OF PROPORTIONS TEST OF STATISTICAL SIGNIFICANCE:

Treatment 1: $p < .10$
Treatment 2: $p < .01$
Treatment 3: $p < .09$
Treatment 4: $p < .05$
Treatment 5: $p < .01$
Treatment 6: $p < .3$
Treatment 7: $p < .3$
Treatment 8: $p < .01$
All: $p < .001$

APPENDIX F

SPECIFICATIONS

MECHANIZED REFUSE COLLECTION VEHICLE & 2 TRANSFER TRAILERS

GENERAL REQUIREMENTS:

Equipment shall be specially designed and fabricated to perform two unique functions in the city's special mechanized system. First, it shall expeditiously pick up and dump the city's 80-gallon residential containers, and second, the collection vehicle shall work together with the transfer trailers to transfer large accumulations of refuse for delivery to a disposal site. The general intent is to obtain high quality, dependable, efficient equipment ready for regular and normal use in the city's collection and disposal systems.

The Council will carefully consider any proposal offered, will compare the cost of operation, the level of service provided, the system flexibility, and will determine which proposal provides for the best interest of the city, may waive specified requirements and will award the bid accordingly.

Specifications For Collection Vehicle:
Collection System:

The vehicle shall be equipped to collect refuse mechanically. It shall be simple to operate and shall meet the following performance requirements.

1. It shall be capable of collecting an 80-gallon container weighing at least 200 pounds, located with its nearest edge no less than 10 feet from the nearest point of the truck. It is desirable that the equipment be capable of engaging the container over the top of a passenger car with a roof height of 5 feet.

2. It shall be capable of engaging, dumping and replacing a container in normal operation with the 200 lb. container within 3 feet of the truck with a cycle time of no more than 10 seconds. Cycle time shall be from truck stop to truck start with an experienced operator.

3. It shall be capable of simple, convenient operation by the vehicle operator without leaving his normal truck operating station and without using more than one hand and one foot to operate controls. The normal operating station shall be from the right-hand drive.

4. It shall operate without straining or damaging the containers and without subjecting them to a radial force in excess of 200 pounds, nor abrading the surface, nor otherwise damaging or discoloring the containers.

Compaction and Storage Systems:

The compaction system shall be capable of continuous operation to remove refuse from the dump hopper at a rate of no less than 1 cubic yard of dumped material per minute. The hopper shall be cleared continuously in such a way that the collection work can proceed uninterrupted.

The storage body shall have a capacity no less than 25 cubic yards and the vehicle shall receive in normal operation, collecting ordinary household refuse, no less than 12,000 pounds payload without overloading either axle.

The body shall be fabricated from high tensile steel with a floor no less than ten gage, side walls no less than 14 gage and top no less than 16 gage, but in any case no less than the manufacturer's standard for similar equipment. Welding, painting, reinforcing and other standards of construction shall be at least equal to that of the bodies currently in operation in the city's system and furnished by Western Body and Hoist in their Wesco Jet.

Ejection and Transfer System:

The ejection system shall be capable of ejecting material from the storage body into the special transfer trailer or at the disposal site and of pushing material against the ejection plate at the opposite end of the trailer. The vehicle will also be equipped with a transfer system that will permit the operator to link with a special trailer, raise the tailgates of both the trailer and vehicle, and transfer material from the collection vehicle to the trailer without requiring assistance and without requiring the operator to leave the cab of the collection vehicle.

Collection Vehicle Chassis:

The collection vehicle chassis shall conform insofar as is practical, with the following detail specifications:

G.V.W.	34,000 pound minimum
C to A	Approximately 120" of frame to be altered. See frame and drain line specs.
Engine	160 to 180 H.P. 4 cycle diesel. Full flow oil filter. Luberfiner 750 by-pass filter or equal. Dual filters (primary and secondary). United Tri Phase air cleaner or equal Donaldson. (Must be spin type filter with dirt ejector).
Cooling	Manufacturers maximum cooling system available. This unit will be operating starting and stopping in low gear ratios at approximately 100 feet intervals on streets without benefit of higher engine R.P.M. or high speed air flow. Air operated radiator shutters optional as required by engine manufacturer. Perry throw-away type cooling system conditioner.
Fuel Tank	Sixty gallon (60) mounted on right side frame rail.
Transmission	Allison Mt. 41 automatic matched to engine. Hayden transmission cooler mounted in front of radiator in direct engine fan air system.
Drive Lines	Heavy duty for off highway operation. Must be two (2) piece drive line with courier and hanger bearing.
Front Axle	12,000 pound Extra heavy duty shock absorbers.
Front Springs	Adequate for 12,000 pound loading.

Rear Axle	22,000 pound single speed. Minimum 7.0-1 ratio wide track axle acceptable.
Tires & Wheels	15 X 22.5 - 16 ply nylon premium tires on 10 hole disc wheels. If front and rear axle wheels are not interchangeable, one (1) spare wheel and tire shall be furnished for each axle.
Steering	Hydraulic power assist with pump drives independently from water pump or fan.
Frame	Single channel, no reinforcements. Frame is to be modified and reinforced by body builder.
Brakes	Full air, 12 cubic foot compressor minimum piggy-back safety brakes with auxiliary air tank for emergency release of safety brake and dash mounted release control. No drive line parking brake. Aeroquip type base on all air lines. No copper tubing. Wet air tank to be equipped with #281923 Bendix automatic drain valve.
Electrical	12 volt, 55 amps alternator minimum. Motorola, Prestolite, Delco or Autolite only. Transistorized voltage regulator. Four (4) 6 volt group 4 batteries mounted together on frame rail away from cab. Dual electric or air operated windshield wipers. Hobbs hour meter mounted in dash. Engine oil temperature gauge mounted in dash. Factory installed air conditioning system or approved package equal to Mark IV or Frigi-King. Fresh air heater and defroster. All head, tail and clearance lights to conform to 1 C.C. specifications. Minimum six (6) inch back up lite at rear of frame with independent cab switch control.
Horn	Single or dual air horn.
Mirrors	6 X 16 Retractable type on each side of cab.
Tow Hooks	Tow hooks on front of frame.
Cab	Steel or fiberglass tilt cab. Two (2) grab handles one at each door. Cab shall be modified to provide right hand drive. Dual sun visors. Premium driver's seats, one (1) to be on each side of cab. (Passenger seat to be premium type driver seat). Safety belts for driver and passenger. CAA and SAE approved. Tinted glass all around. Floor covering to be heat resistive pad under aluminized back carpeting for maximum heat restriction to operator. Cab to be low mount type for easy access of operator for numerous exit and entrances.
Safety Bell	Real wheel mounted reverse warning bell.
Color	Fawn Beige. Dupont #4854D, or equal, on cab and body.
Auxiliary Engine	Perkins 4-236 preferred. Oil pressure and water temperature gauges to be mounted on engine. 500 Luberfiner by-pass oil filter. United Tri Phase or Donaldson spin type air cleaner with dirt ejector. Primary and secondary fuel filters. Shall be started, stopped and speed controlled from the normal right hand drive operator's station.

Specifications For Transfer Equipment
Transfer Trailers

Transfer trailers shall be designed to be compatible with and to work in conjunction with the collection vehicle. The transfer system shall be capable of expansion to other pieces of equipment in the city's fleet. The system shall deliver no less than 90 cubic yards of compacted material and no less than 45,000 pounds from the collection vehicle specified above.

Trailers shall be equipped to operate with a standard tractor equipped with a fifth wheel. They shall be equipped to be simply and easily connected to the hydraulic, air and control system of the tractor and use interchangeably with it. The trailers shall normally be used by storing one on a convenient street or parking area while the other is in transit to the landfill. The bidder shall include in his bid the cost of installing the hydraulics and control system in one tractor. The system shall operate so that all functions involved in removing and disposing of refuse can be accomplished by the operator from his cab without leaving his operating station in the cab except to make quick-connect connections or disconnections of the hydraulic, air and electrical operating and control systems between the tractor and the trailer. The linking system and tailgate system shall accommodate the transfer without spilling refuse. Trailers shall be equipped with special feet hydraulically operable to lift the trailers off of the tractor and to replace them on it.

Trailers shall be welded, painted, fabricated, reinforced, and otherwise constructed to standards at least equal to that of bodies currently in operation in the city's system and furnished by Western Body and Hoist in their Wesco Jet.

Trailers shall be fabricated in accordance with the following detail specifications:

TRASH HOG TRAILER DETAIL SPECS

Length	Approximately 55 feet to be indicated on Purchase Order.
Width	Maximum legal. Capacity shall be no less than 120 cubic yards inside volume.
Rear Axle	34,000 lb. capacity tandem with Neway non-lubricated suspension.
Wheels & Tires	Nine (9) 1000 X 15 - 14 ply premium tires on 10 hole disc wheels.
Brakes	Largest size available with self adjusting wedge type air actuation. To be equipped with all automatic safety controls to comply with I.C.C. regulations.
Kingpin	Approximately thirty-six (36) inches from front of trailer. To be designated on Purchase Order.
Hydraulics	Trailer hydraulic system shall be coupled to tractor with quiet detachable, self sealing couplings. Power source shall be from P.T.O. of Allison MT 41 Transmission on truck tractor with all controls in cab of truck. Pump size, hose sizes, and valving shall be of adequate size to give fast operation and long life with minimum maintenance. Hydraulic system shall have throw away type filter. Sixty (60) gallon hydraulic oil reservoir will be installed on truck by truck Manufacturer. Bidder shall furnish power take-off and all

other hydraulic and control equipment, mounted on the tractor. Hydraulic operation of trailer shall be, rear door, ejector plate and landing gear. System shall be designed so rear door can be opened and closed manually when trailer is not connected to truck tractor. Control valving shall be electric-hydraulic mounted on trailer with electric switches mounted in truck cab and connected to trailer with standard trailer electrical quick connect plug of same type as used for trailer lights.

Landing Gear Hydraulically operated from truck tractor cab, with oversize sand pads. (No wheels). Lift capacity shall be in excess of 30,000 lbs. Landing gear shall be so constructed to withstand horizontal shock of connection of refuse truck as it is coupled at rear end of trailer in order to transfer load.

Electrical All lights shall be installed to comply with I.C.C. regulations.

The Following Schedule Shall Be Observed In Conformance With These Specifications:

1. Prior to award, the city may require preliminary conceptual drawings of the proposed system in order to compare and evaluate proposals. The bidder should expect to submit such drawings with his proposal or within 10 days after the bid opening should his offer be considered for evaluation.

2. Within 45 days after the bid award the bidder shall submit detailed engineering drawings (but not necessarily fabrication drawings) which shall show the sizes and particular components proposed to be used. These plans will be reviewed and approved, conditionally approved or disapproved by the city within 15 days after receipt.

3. Within 120 days after the bid award the collection vehicle shall be delivered.

4. Within 150 days after the bid award the first transfer trailer shall be delivered. The bidder may use the city's tractor, which shall be delivered to his shop for modification, to transport the trailer. The contractor may then work with the city for 30 days to modify or improve the transfer system to assure that it works satisfactorily.

5. Within 200 days after the bid award the second transfer trailer shall be delivered. The city will haul the trailer at it's expense up to 500 miles and will haul for $0.50 per mile any additional distance.

The bidder shall bear responsibility for patent protection and shall have the responsibility to provide the city with equipment which can be regularly used without patent liability. The bidder shall make his own arrangements to secure any patents or licenses needed to provide the equipment required by these specifications.

APPEXDIX G

PHASE II - ATTITUDE SURVEY

The following is an extract from an attitude survey during Phase 2 by Dennis Schweigert, a graduate student.

Survey Data

Objective. A survey was conducted to determine the attitude of customers toward the service provided by this new refuse collecting system. Specifically the survey sought attitude responses to the following two questions:

1. Is the new mechanized method an improvement over the old method?
2. Is the refuse being collected satisfactorily by the new system?

Nature of the Survey Universe. Scottsdale, Arizona is located in the Salt River Valley 8 miles Northeast of downtown Phoenix. It covers 63 square miles and has experienced a rapid growth rate since 1950. In 1965 the population was 54,504 with an average per household of 3.6 persons. In 1970, the population was 71,800. In 1965 the City had 16,183 residential dwellings. The following table lists the breakdown by housing type:

Category	Number of Units
Single Family	12,317
Multiple Family	3,613
Mobile Homes	253

In 1966 the median family income was over $9,000 and serves as a measure of the community's well being. The 1960 census shows the median years of school completed by residents over age 25 was 12.7.

Sampling Units - Description and Characteristics. The survey was conducted in two different residential areas that have been receiving the mechanized refuse collecting service for at least one year. Group I was served by the Barrel Snatcher and 300-gallon containers and had alley service. The homes in Group I were built by Allied Construction Company in 1959 and 1960 and are all single family dwellings. Group II was served by the Barrel Snatcher and 80-gallon containers and had street, curb-side service. The homes in Group II were built by Hallcraft Construction Company in 1964 and 1965 and all are single family dwellings. The two residential groups may be described as white, middle class neighborhoods. Both groups were formerly served by 3-man crew collection trucks and train type transfer stations. Figure G-1 illustrates the area and location included in Groups I and II.

Sample Size. The total number of units in Groups I and II is 742; Group I has 443 houses and Group II has 299 houses. The survey sample size in Group I was 44 units or about 10% of the total group population. The Group II sample size was 42, or about 14% of the group's population. Sample size was determined arbitrarily based on two considerations. The first was that sample size over 30 units was needed so that the data could be analyzed as a large sample; the second was that a time limitation was imposed by outside factors so a large sample could not be taken.

Survey Design and Method. The sample units were selected by choosing every 10th house in Group I and every 6th house in Group II from a city plat. In so doing the areas surveyed were evenly dotted with sample units. Although this is not a probability sample, the sequential sampling method used is thought to be a representative sample for the purposes of this report.

The survey form featured 24 questions. The first was a multiple choice question to determine the respondent's awareness of relative operating expense of his refuse collecting service. Two other questions were open-ended and the remaining 21 questions were objective type featuring a rate scale response. A pretest on the survey form was conducted and modifications were made. The survey was conducted by the writer and a staff member of the Public Works Department of Scottsdale. Because of the time limitation, no call backs were made to not-at-home units. In the case of a not-at-home unit, the interviewer called on the house next door. It is recognized that the use of the house next door may be biasing because the family structure may be different and different attitudes may exist; however, the time limitation for completion of the survey was the overriding factor. About 31% of the resonses in Group I were not-at-home; the proportion of not-at-home responses was about 20% for Group II.

Questions 3, 4, 10 and 11 on the form was used to determine the attitude toward the basic question: Is the refuse being collected satisfactorily by the new system? Questions 5 through 9 and 12 through 17 were used to determine the attitude toward the question: Is the new method an improvement over the old method?

Two independent variables were used in this study: (1) Container size; (2) Number of homes sharing a container. The frequency of pick ups was constant (twice/week) for all units and all containers were city-owned.

The four response choices for each question have been categorized into two basic groups that reflect either a favorable or unfavorable attitude toward the new mechanized refuse collection system. No provision was made in the rated scale response for a null or indecision answer to encourage the people to commit themselves to an attitude about the subject. However, where a null response was given, it was recorded and is included in the analysis; no attempt is made to hide it or ignore it. The effect of the non-response bias is thought to be small because the number of null responses is relatively small.

Survey Results

The responses of the 86 observations are categorized into two groups corresponding to the two basic attitude questions stated in the survey objective. These grouped responses are further divided into categories representing the two different survey areas -- those having 300-gallon containers and those having

80-gallon containers. This Appendix contains bar charts illustrating the responses to all the rated scale questions for Group I and Group II (Figures G-2 through G-37).

A student "t" analysis was applied to the data to determine significant differences in the responses and is summarized in Table G-1 of the Appendix. A test of significance was not performed on all questions; rather only the cumulative responses (Figures G-2 through G-7) and those questions with the smallest difference between favorable and unfavorable responses were tested. All others are found to have a higher level of confidence that a significant difference in attitude exists. For most of the responses, we are more than 99% confident that a difference exists between the number of favorable and unfavorable attitudes and we may say that we are 99% sure of the validity of our results. Table G-1 in the Appendix lists the results of the student "t" analysis.

The cumulative attitude response of both Group I and Group II is 72.9% favorable to the question: Is the new method an improvement over the old method? In other words, 72.9% of all the people surveyed favored mechanized collection over the previous collection system.

Most of the people surveyed thought the refuse was being collected satisfactorily; 87.6% of the responses were favorable to this question.

Only three questions in this survey received insignificant response results. The questions are Nos. 10, 13, and 16 shown in Figures G-10, G-18, and G-21 of the Appendix. These responses represent divided opinions or attitudes and all came from Group II. These results are explainable: The response to question 10 concerning proper container replacement after emptying is likely to be critically judged when you consider the customer has to retrieve the container from the street curb after the refuse has been collected. If the container isn't exactly where the customer left it, he may develop a negative attitude about container replacement; in any case, he's more likely to be conscious of replacement than the customer served by the 300-gallon containers. The larger containers require no retrieval by the customer and are located in the alley as opposed to the front yard for collection.

The response to question 13 regarding the reduction of noise when collecting refuse is related to the exposure time of the noise. In Group I where 300-gallon containers are used, the truck stops once for every fourth house thus transporting through a neighborhood faster than it does when it must stop for every house as it does on Group II for the 80-gallon containers.

The response to question 16 about the prestige to the neighborhood brought by the new refuse collecting system may be related to the younger age of the people surveyed in Group II (mean age = 30.4 years in Group II and mean age = 38.8 years in Group I) and to the newer homes in Group II. Group II showed a higher null response (no answer given) than Group I which is interpreted to mean that fewer people took the question seriously in Group II than in Group I.

When asked if they thought the new collection system resulted in a cost savings, 71.4% of the response in Group I and 70.5% in Group II indicated yes. In Group I, 78.6% and in Group II, 88.6% thought there was a savings in time with the mechanized system. Figures G-12, G-13, G-27, and G-28 in the Appendix graphically display these responses.

The responses to questions 7 and 17 asking if the customer would prefer going back to the old method of refuse collection are more than 75% in favor of keeping the new system.

Tables G-2 and G-3 in the Appendix list the predominant complaints of the people in Groups I and II. Also listed are a tabulation of responses to questions 18 through 23 and replies to the initial survey question: Which of the city services consume the largest portion of the city's budget?

The predominant complaints of the customers in Group I concerned insufficient container capacity or the need for more frequent pick up, and the need for a container sanitation program. Eight of the twelve complaints about container size came from households having four or more people.

The predominant complaint from Group II centered on broken or cracked containers. Five of the six complaints came from families of three or more people. The customers blamed the truck for the breakage. Only three customers complained of container capacity, and they had four or five people per family. There were no complaints from Group II about container cleanliness, sanitation, or odors.

Tables G-4 and G-5 list demographics of Groups I and II.

Survey Conclusions

A significant majority of the 86 Scottsdale residents surveyed believe the mechanized system of refuse collection is an improvement over the previous system after one year's experience with the new system. The majority of the people surveyed are satisfied with their refuse collection service. Three needed improvements cited by the residents were more container capacity (or more frequent pick up) for containers shared by four households, a sanitation program for the 300-gallon size containers, and more durable 80-gallon size containers. Most of the customers see savings in time and money with the mechanized system.

SCHEDULED HOUSE

DIFFERENT HOUSE

SHEET NO. ____
DATE ________
TIME ________

ATTITUDE SURVEY
OF
MECHANIZED REFUSE COLLECTION
IN
SCOTTSDALE, ARIZONA

STREET ______________________________ NUMBER ______________________________

DWELLING TYPE: HOUSE ________ TOWNHOUSE ________

RESPONDENT: AGE _____ SEX _____ FAMILY POSITION: Father

Mother

Child

EVER INTERVIEWED BEFORE FOR THIS PROGRAM? YES _____ NO _____

HOW MANY LIVING AT THIS ADDRESS? ______

1. Which of the City services consume the largest portion of the City budget?

   Fire Protection
   Police Protection
   Refuse Collection
   Administrative Overhead
   Street Repair & Construction

2. Are you satisfied with your refuse collecting? Why or Why Not?

	AGREE 1 2 3 4 DISAGREE
3. The City is doing a competent job of refuse collecting.	______________________________
4. Your refuse is collected often enough.	______________________________
5. You think it costs less to collect refuse by hand than by machine.	______________________________
6. You think it is faster to collect refuse by hand than by machine.	______________________________
7. You would prefer going back to the former method of refuse collection.	______________________________

AGREE 1 2 3 4 DISAGREE

8. The noise of collecting refuse by the former method bothered you. ____________________

9. The new cans help reduce odors around refuse containers. ____________________

10. Refuse cans are replaced properly by machine after emptying them. ____________________

11. The City employees who collect refuse are doing a good job. ____________________

12. The area around the new refuse containers is easier to keep clean with the new system. ____________________

13. Use of the new system reduces noise when collecting. ____________________

14. Use of the new system helps improve the appearance of the neighborhood by having fewer containers and by keeping it cleaner. ____________________

15. This new system is more sanitary than the previous system. ____________________

16. Use of the new system adds prestige or status to the neighborhood. ____________________

17. The City should go back to the old method of collection. ____________________

18. Who takes the garbage out? Father Mother Child

19. Do you mind using a City provided refuse container? Yes No

20. Do you have a garbage disposal? Yes No

21. Have you ever had a delay in service with the new system?
Yes No Sometime

22. Are the refuse container lids closed after emptying?
Yes No Sometime

23. What kind of container did you use previously?
Metal Plastic Other

24. How can the service of collecting your refuse be improved?

TABLE G-1

TEST FOR SIGNIFICANT DIFFERENCE IN SURVEY RESPONSES

The difference test used here is the Student "t" Test.

Sample Calculation:

$$S_1 = \frac{P_1 \quad (1-P_1)}{n - 1} = \frac{(.733) \ (1-.733)}{88 - 1} = .04742$$

$$S_2 = \frac{P_2 \quad (1-P_2)}{n - 1} = \frac{.237 \quad (1-.237)}{88 - 1} = .04558$$

$$t = \frac{P_1 \quad -P_2}{S_1 + S_2} = \frac{.733-.237}{.04742 + .04558} = 5.333$$

Confidence Level = 99.98%; this value was taken from a table of the cumulative normal distribution function.

P_1 = proportion of favorable responses taken from Figure 4.

P_2 = proportion of unfavorable responses taken from Figure 4.

S_1 = Standard deviation of the favorable response.

S_2 = Standard deviation of the unfavorable response.

Figure No.	Confidence That a Significant Difference Exists
4	99.98%
5	99.41
6	99.99 +
7	99.99 +
8	99.99 +
10	33.18
15	99.99 +
18	52.80
21	6.17
25	99.99 +
31	99.99 +
33	80.35
36	95.15

TABLE G-2

CUSTOMER RESPONSE TABULATION FOR GROUP I

Response to the Question: Which of the city services consume the largest portion of the city's budget?

Choice	No. Responding
Fire Dept.	0
Police Dept.	19
Refuse Collection	6
Sewage Disposal	4
Street Repair & Construction	15

Response to the Questions 17 through 22:

Question No.	Choice & Response			
17	Father	Mother	Child	All
	6	8	13	17
18	Yes	No		
	4	40		
19	Yes	No		
	24	20		
20	Yes	No	Time Delayed	
	17	26	Ranged from 1 day to 2 weeks.	
21	Yes	No		
	36	2		
22	Metal	Plastic	Other	
	37	5	2	

Most frequently listed complaints:

1. Need more capacity = 12
   Family size distribution for the 12 respondents = 2, 2, 2, 3, 4, 4, 5, 5, 5, 6, 6, 7
2. Need a container sanitation program = 13
   Family size distribution for the 13 respondents: 1, 2, 2, 3, 3, 4, 4, 5, 5, 5, 5

TABLE G-3

CUSTOMER RESPONSE TABULATION FOR GROUP II

Response to the Question: Which of the city services consume the largest portion of the city's budget?

Choice	No. Responding
Fire Dept.	0
Police Dept.	17
Refuse Collection	7
Sewage Disposal	2
Street Repair & Construction	16

Response to the Questions 17 through 22:

Question No.	Choice & Response			
	Father	Mother	Child	All
17	12	8	9	12
	Yes	No		
18	3	39		
	Yes	No		
19	41	--		
	Yes	No	Time Delayed	
20	26	16	1 day to 1 week	
	Yes	No	Sometime	
21	33	4	5	
	Metal	Plastic	Other	
22	35	4	3	

Most frequently listed complaints:

1. Broken containers = 6
   Family size distribution for the 6 respondents = 2, 3, 3, 4, 5, 7

TABLE G-4

DEMOGRAPHICS FOR GROUP I

House Population = 443 houses

Sample Size = 44 houses

Sex of Respondents:	Male	Female
	10	34

Family Position of Respondent:	Father	Mother	Child
	4	33	7

Age Range:	14 - 74 years
Mean Age:	38.8 years
Median Age:	42.5 years
Tri-Mode Age:	35, 43, and 45 years

Family Size	Number
1	1
2	6
3	11
4	12
5	8
6	4
7	2
8	0
9	0
10	0

TABLE G-5

DEMOGRAPHICS FOR GROUP II

House Population = 229

Sample of Size = 42

Sex of Respondents:	Male	Female
	11	31

Family Position of Respondent:	Father	Mother	Child
	8	26	8

Age Range: 14 - 68 years
Mean Age: 30.4 years
Median Age: 41 years
Bi-Mode: 38 and 40 years

Family Size	Number
1	0
2	4
3	10
4	8
5	9
6	7
7	2
8	1
9	0
10	1

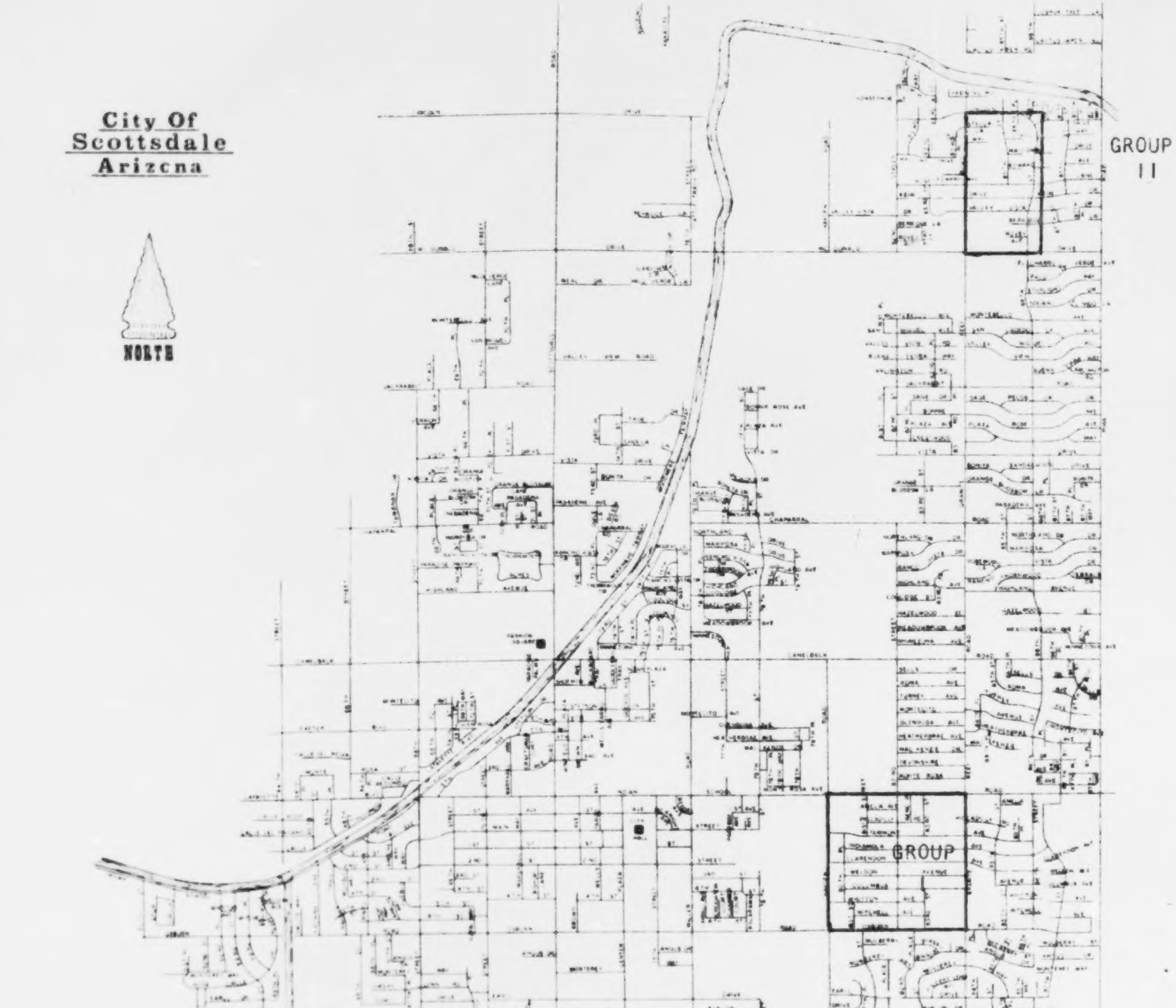
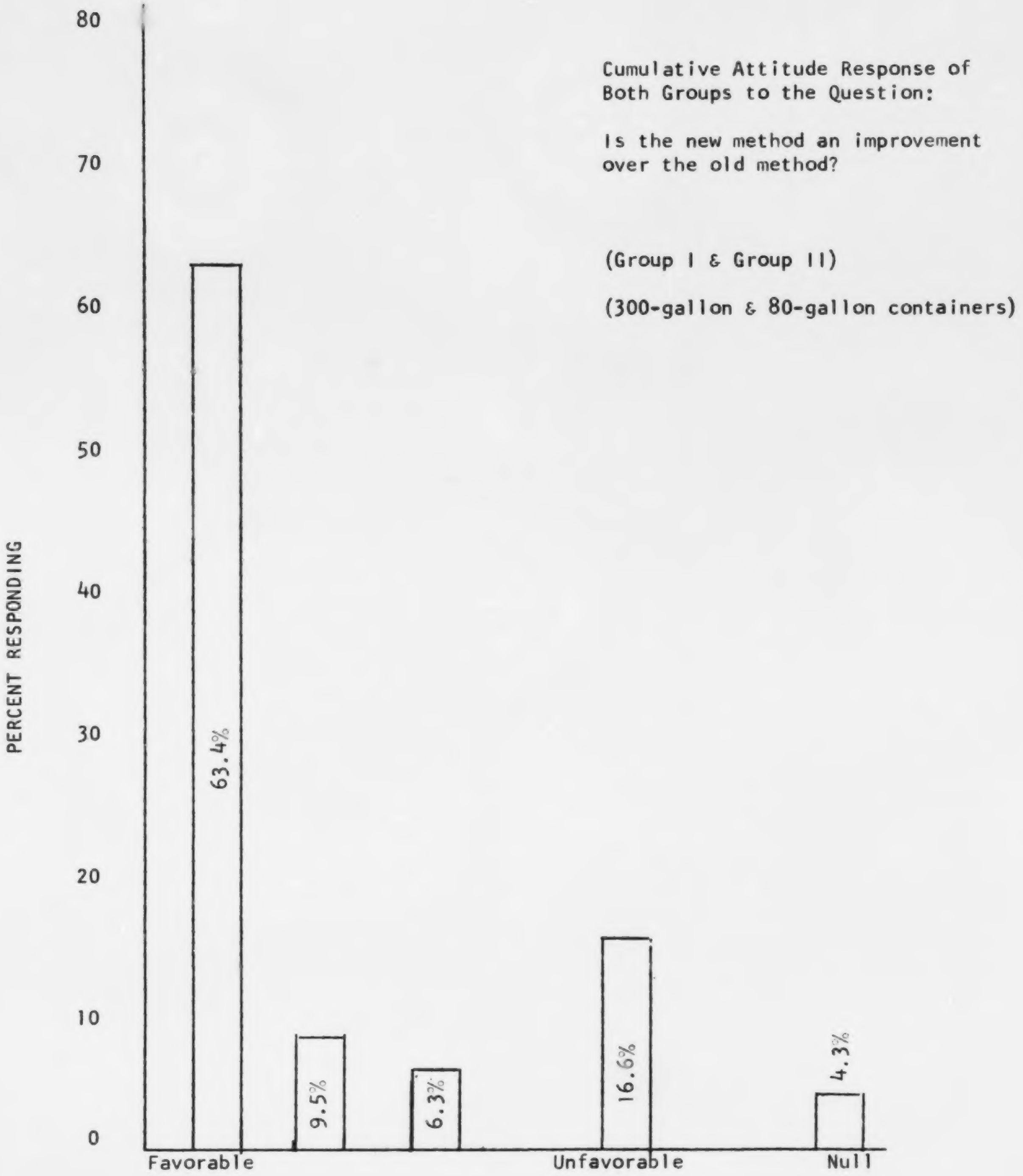

City Of
Scottsdale
Arizona
NORTH
GROUP
II
GROUP

Figure G-1.



Cumulative Attitude Response of
Both Groups to the Question:

Is the new method an improvement
over the old method?

(Group I & Group II)

(300-gallon & 80-gallon containers)

FIGURE G-2. RESPONSE TO THE NEW SYSTEM

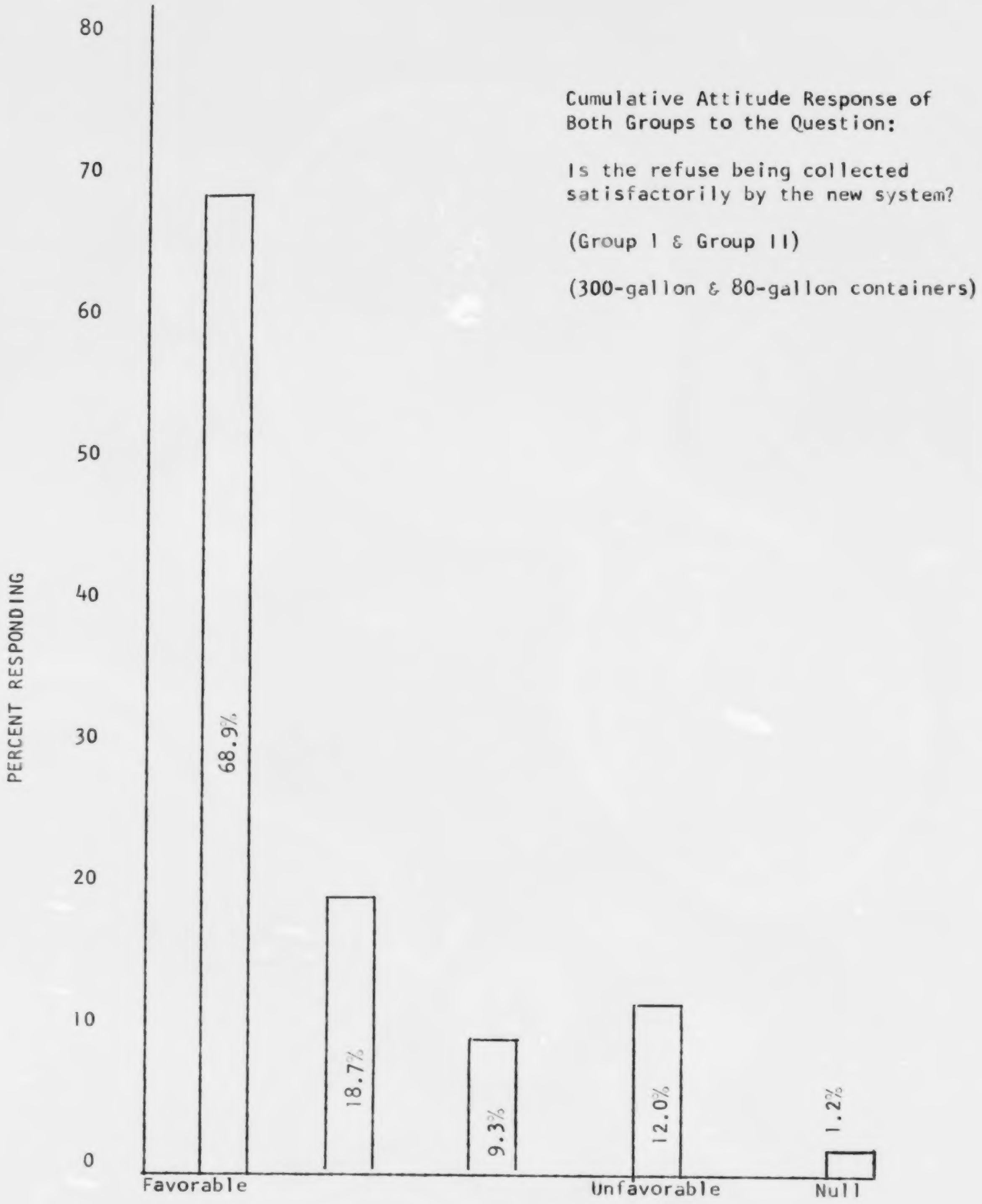
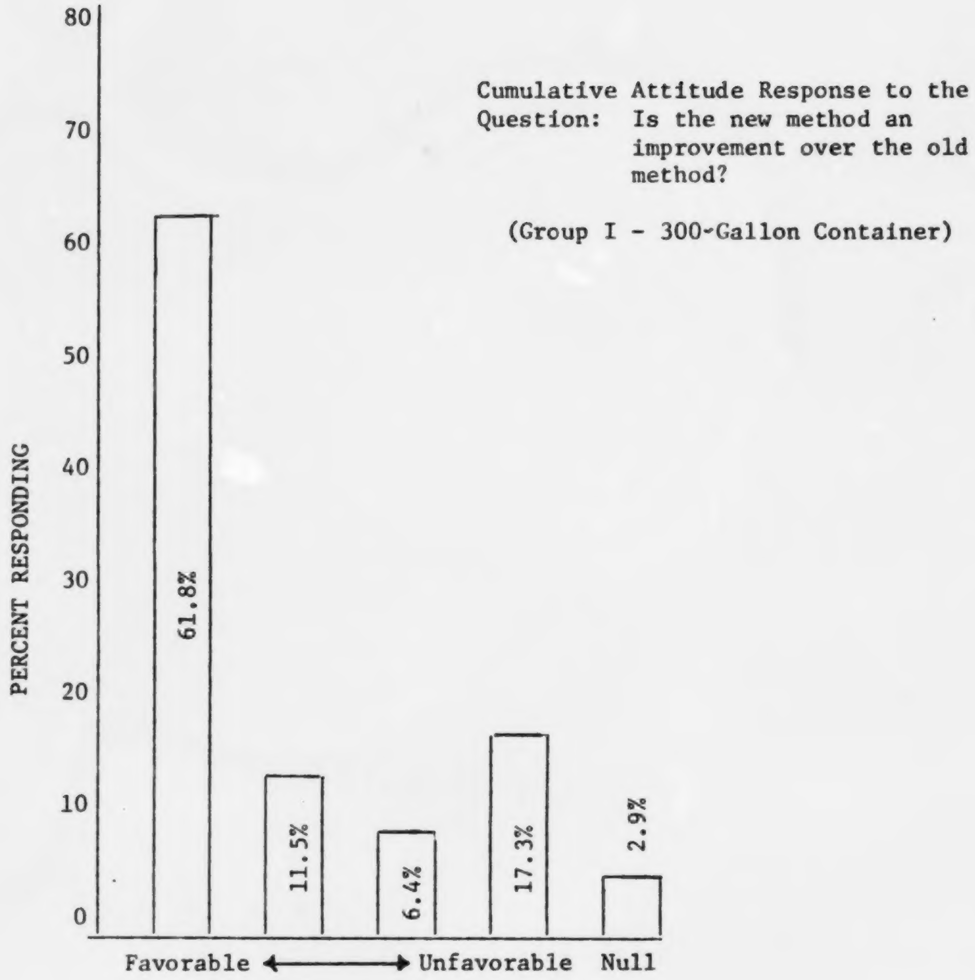


FIGURE G-3. RESPONSE TO THE NEW SYSTEM



Cumulative Attitude Response to the Question: Is the new method an improvement over the old method?

(Group I - 300-Gallon Container)

FIGURE G-4. RESPONSE TO THE NEW SYSTEM

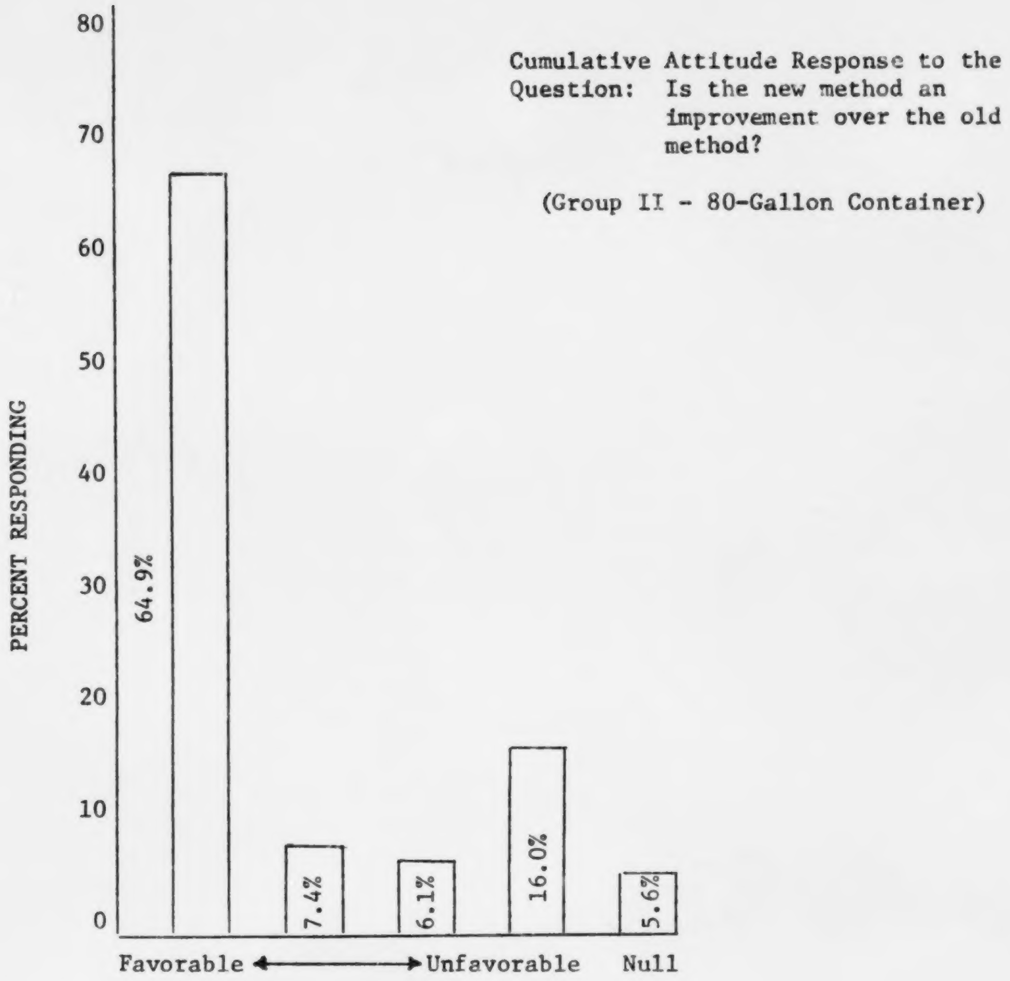


FIGURE G-5. RESPONSE TO THE NEW SYSTEM

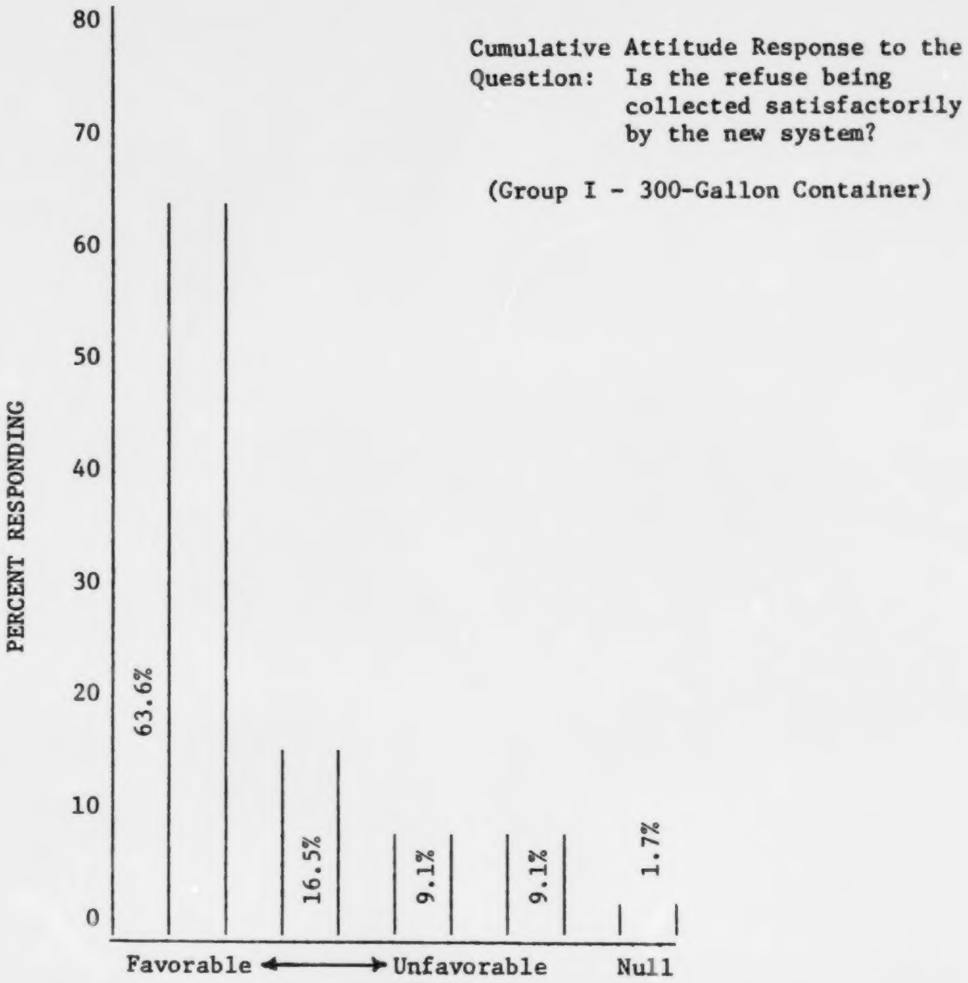


FIGURE G-6 RESPONSE TO THE NEW SYSTEM

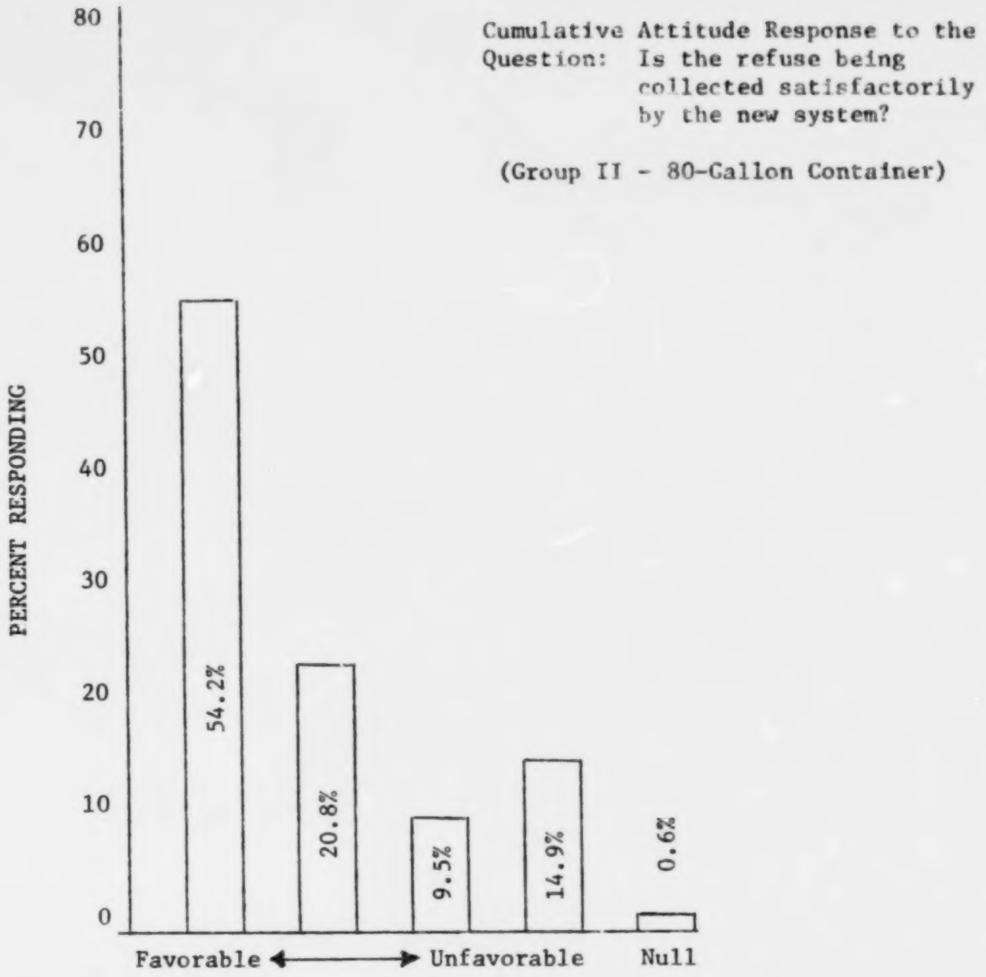


FIGURE G-7. RESPONSE TO THE NEW SYSTEM

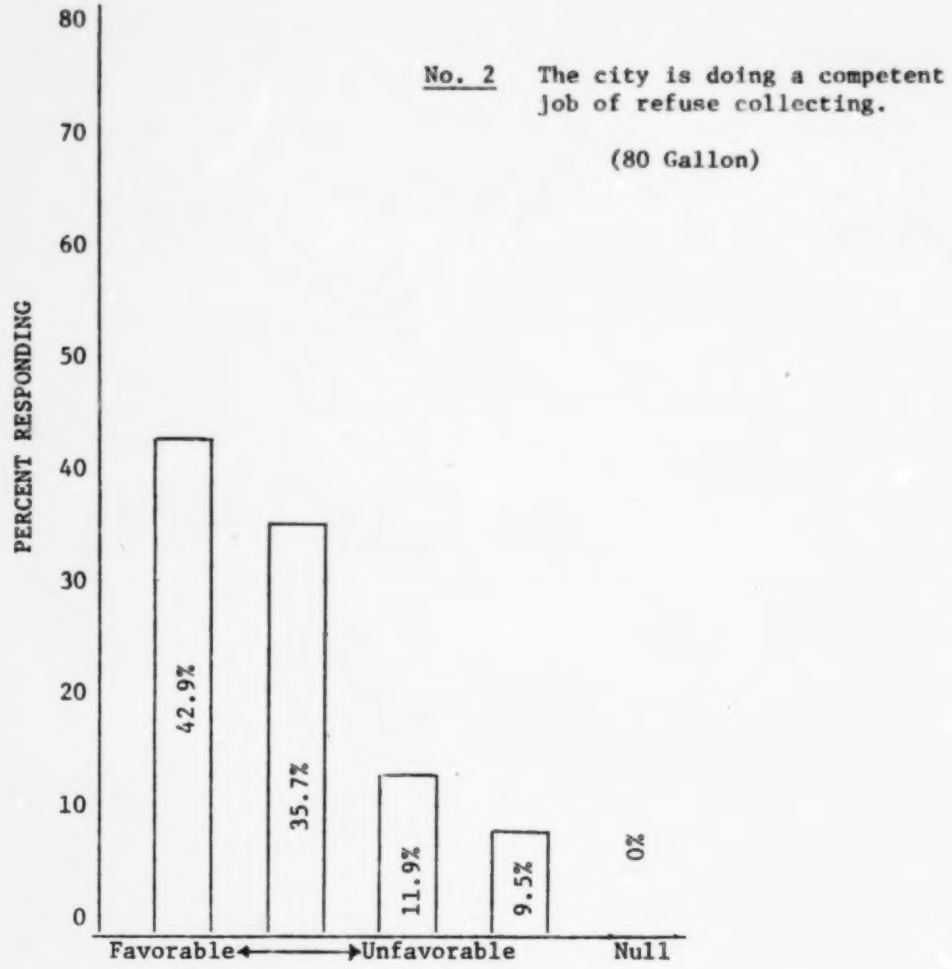
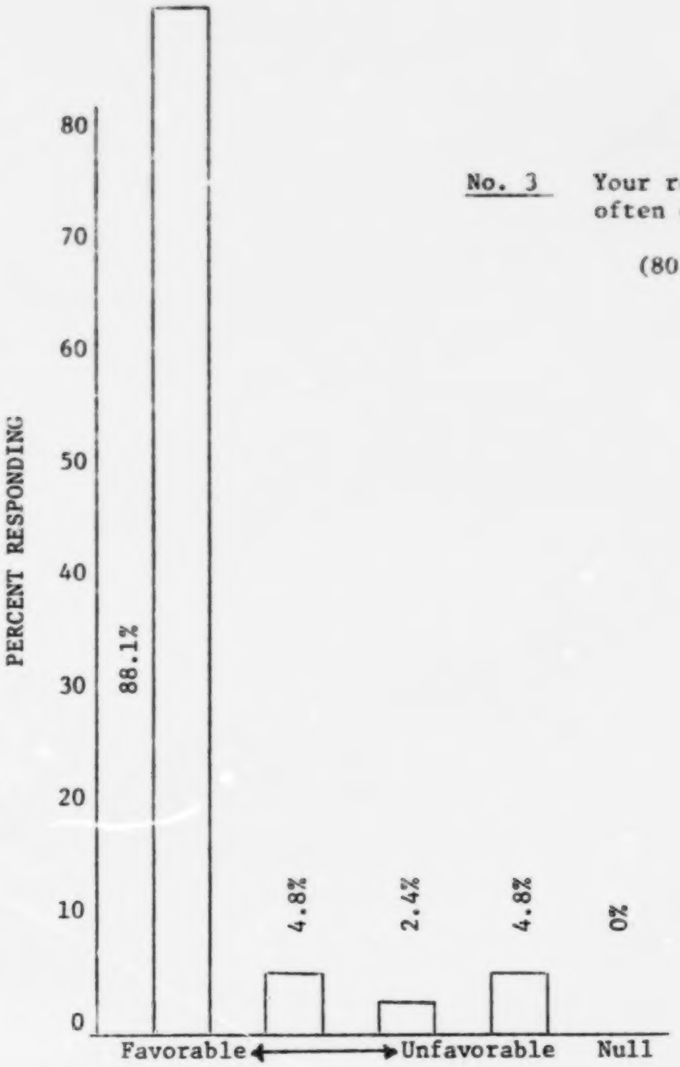


FIGURE G-8. RESPONSE TO THE NEW SYSTEM



No. 3 Your refuse is collected often enough.

(80 Gallon)

FIGURE G-9. RESPONSE TO THE NEW SYSTEM

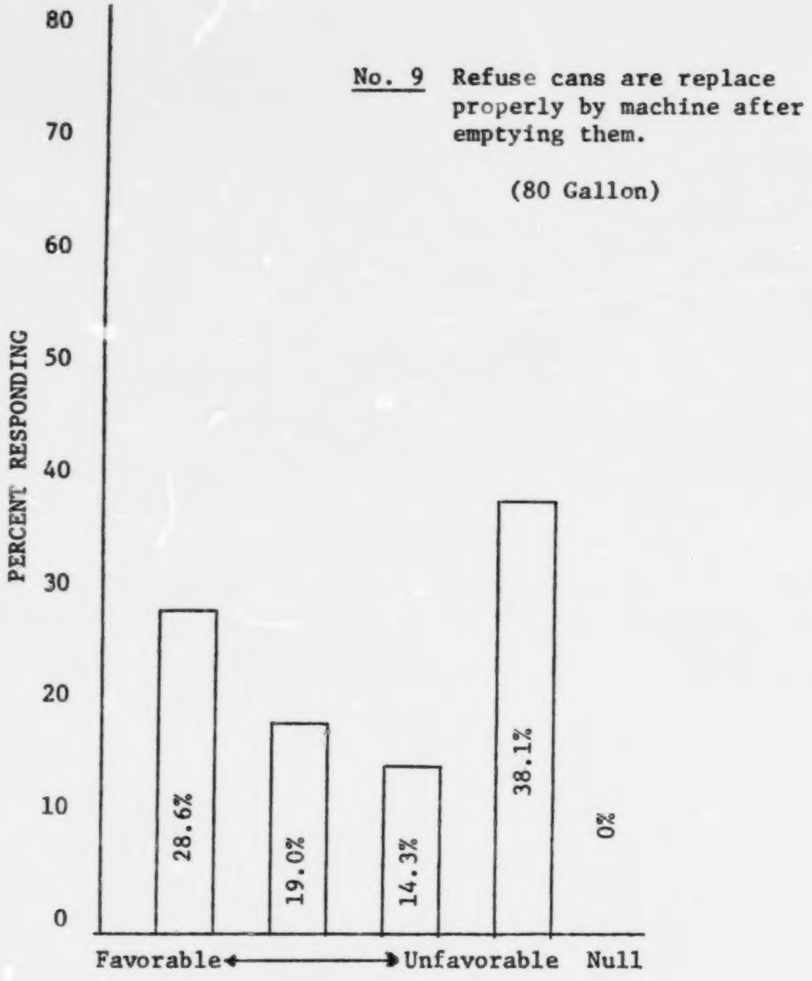


FIGURE G-10. RESPONSE TO THE NEW SYSTEM

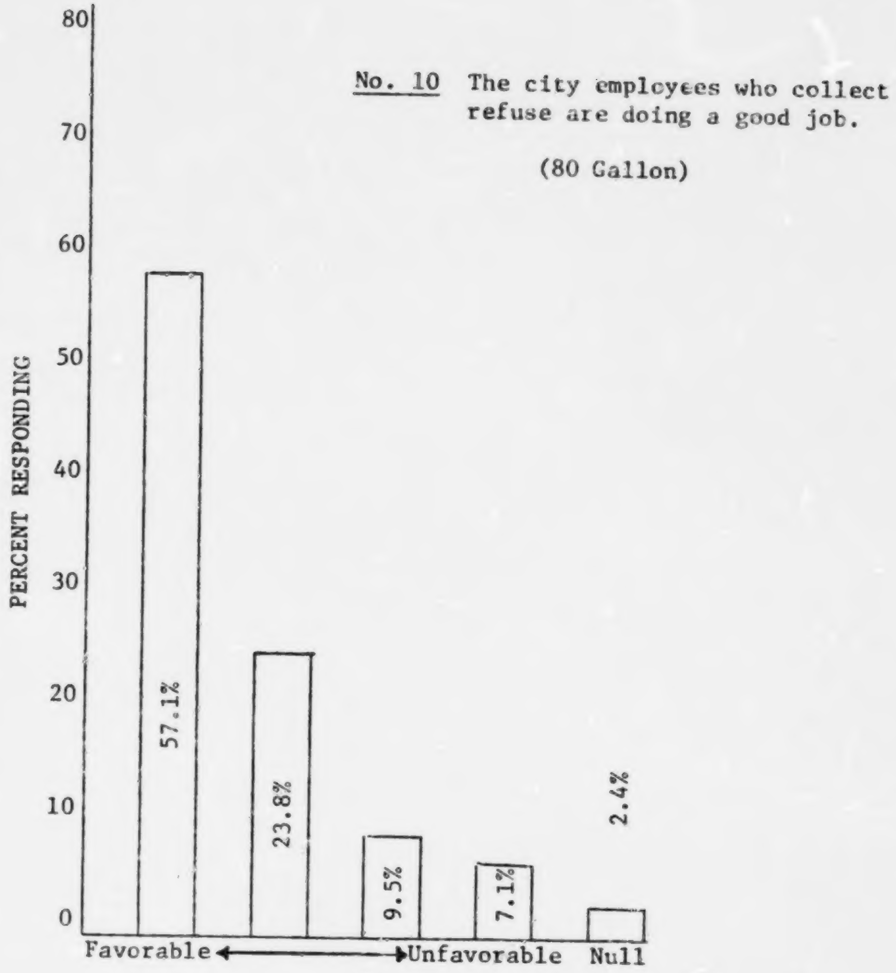


FIGURE G-11. RESPONSE TO THE NEW SYSTEM

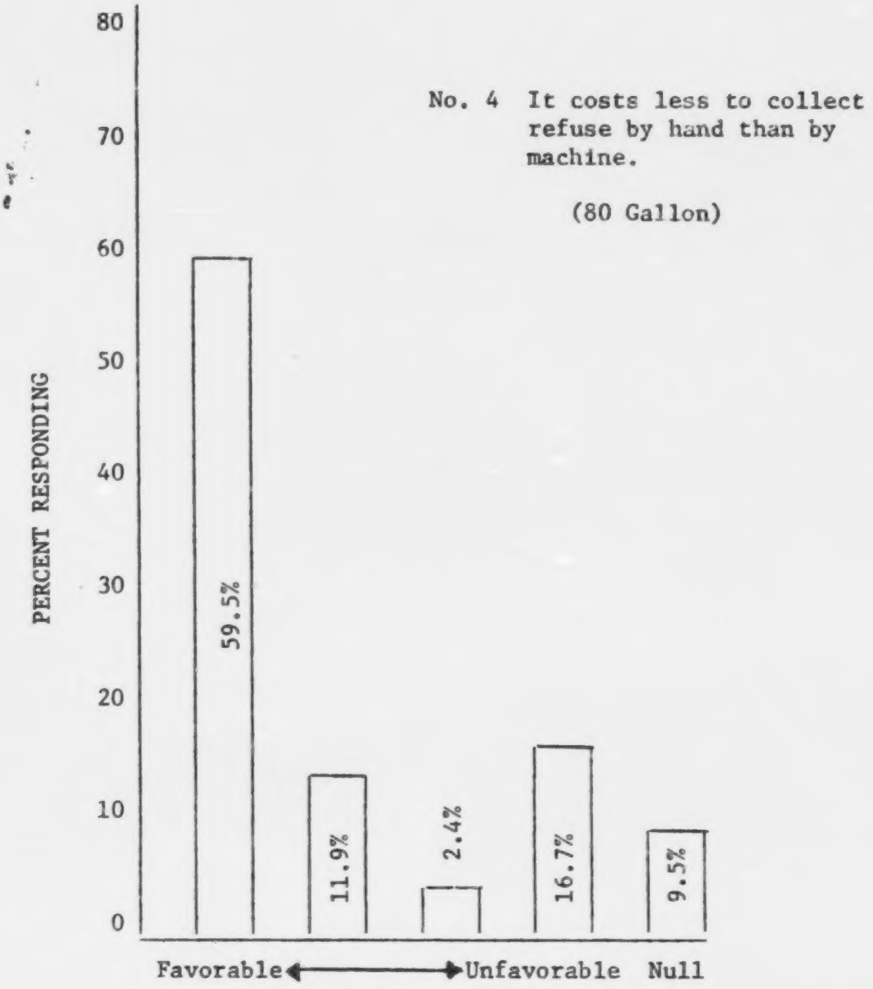


FIGURE G-12. RESPONSE TO THE NEW SYSTEM

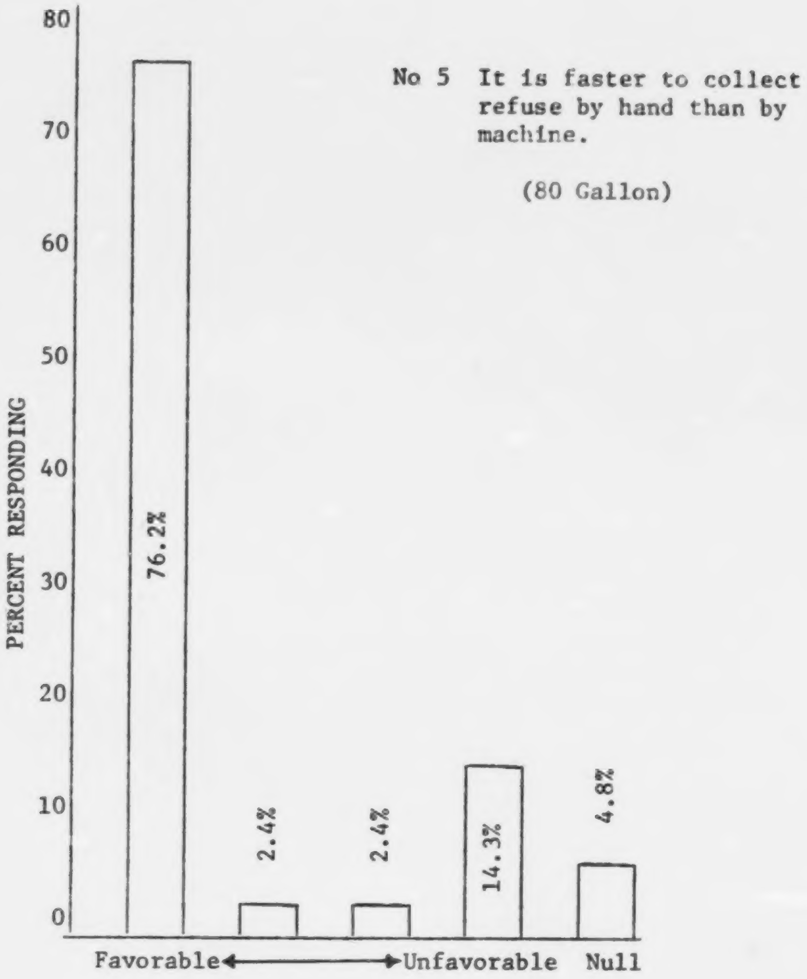


FIGURE G-13. RESPONSE TO THE NEW SYSTEM

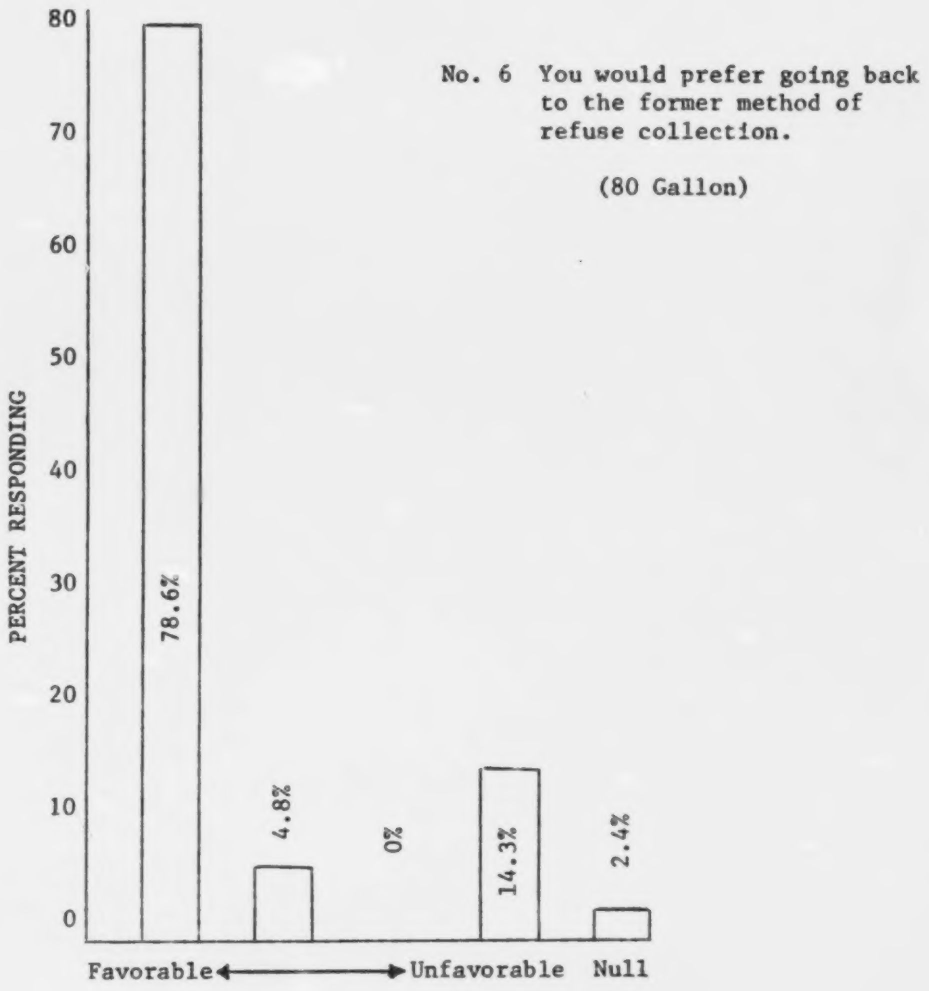


FIGURE G-14. RESPONSE TO THE NEW SYSTEM

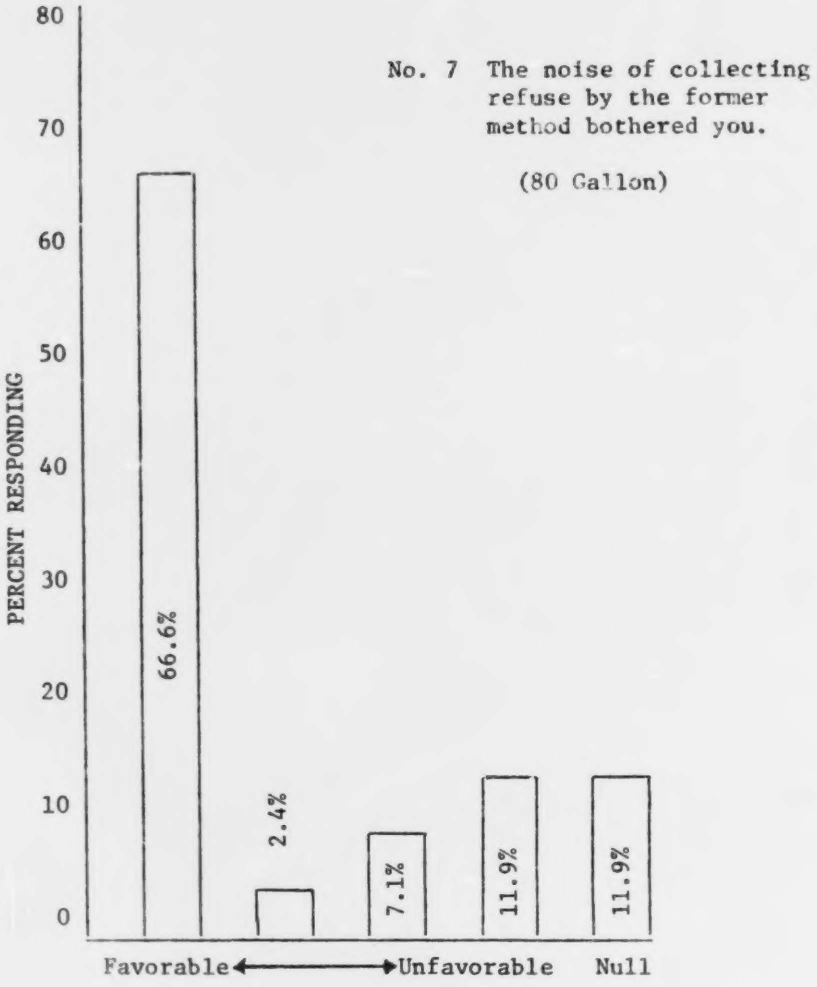
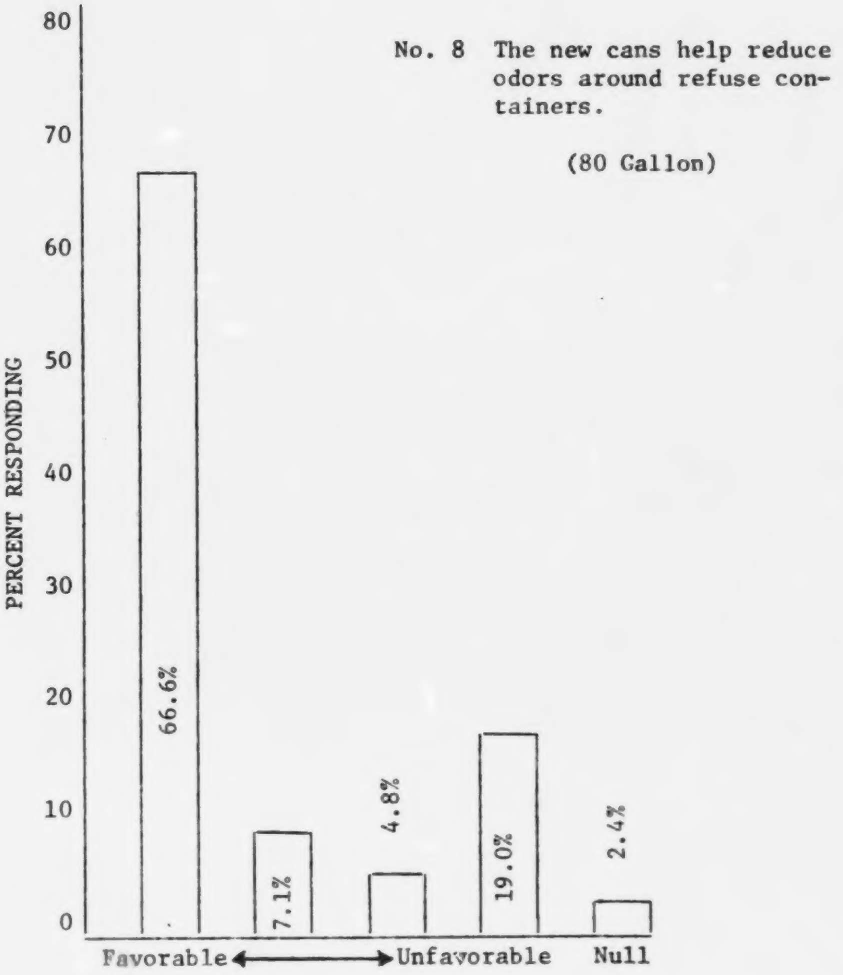


FIGURE G-15. RESPONSE TO THE NEW SYSTEM



No. 8 The new cans help reduce odors around refuse containers.

(80 Gallon)

FIGURE G-16. RESPONSE TO THE NEW SYSTEM

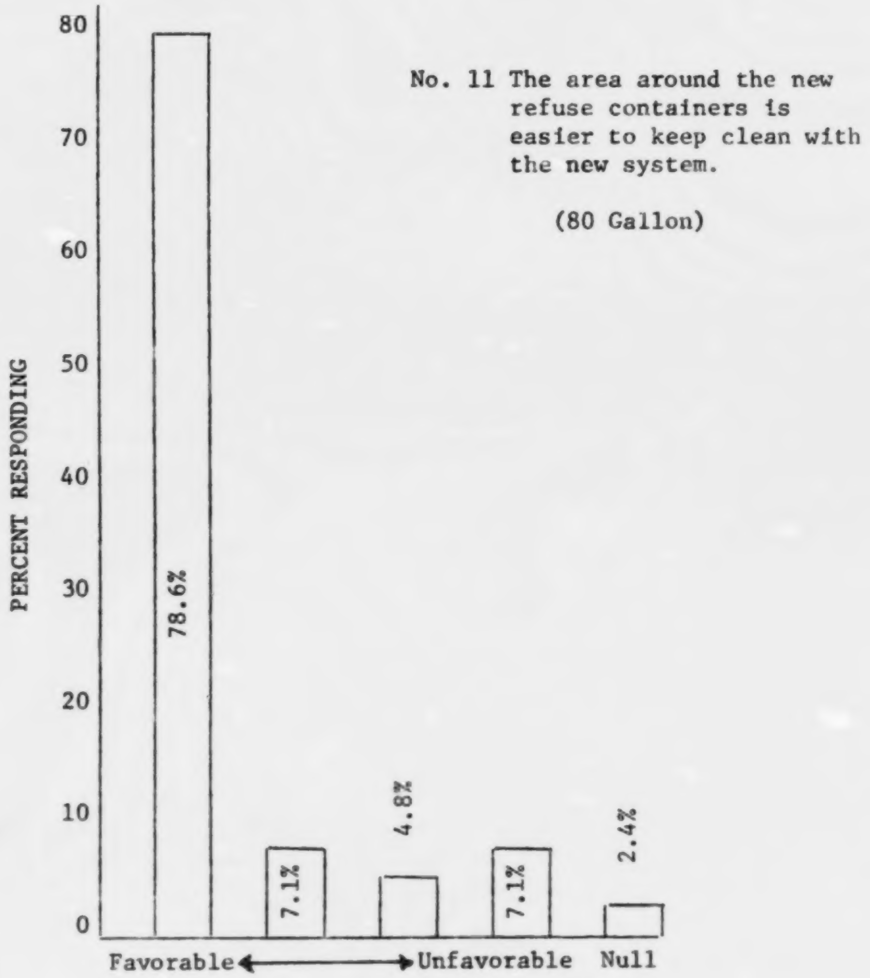


FIGURE G-17. RESPONSE TO THE NEW SYSTEM

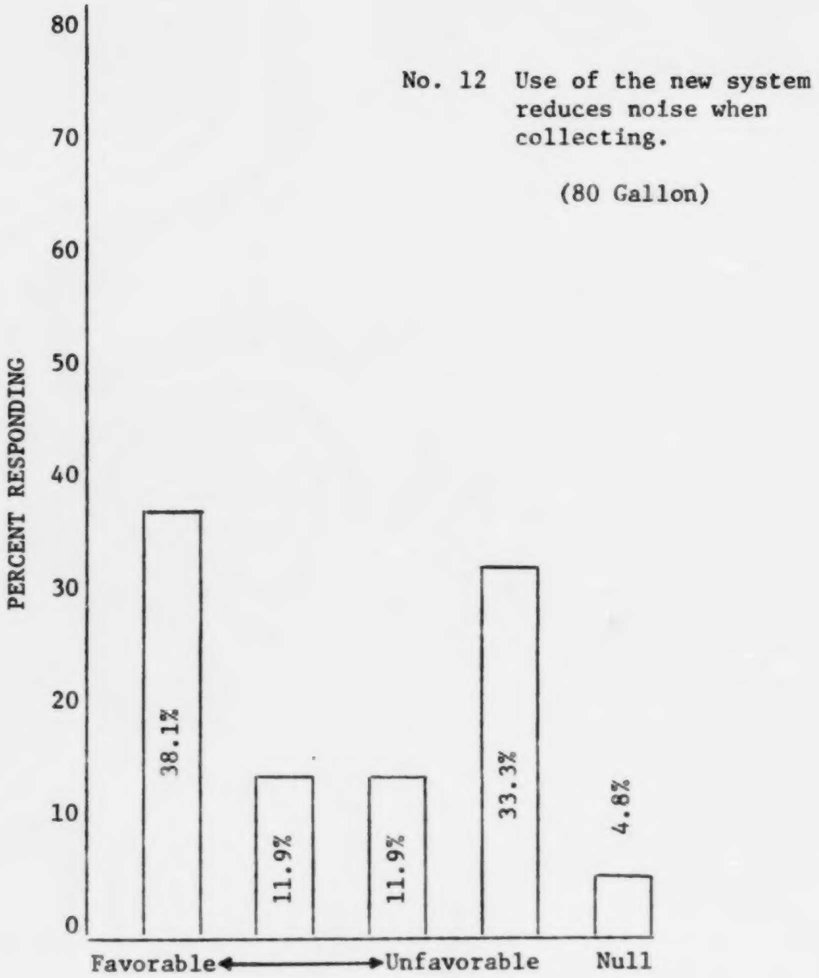
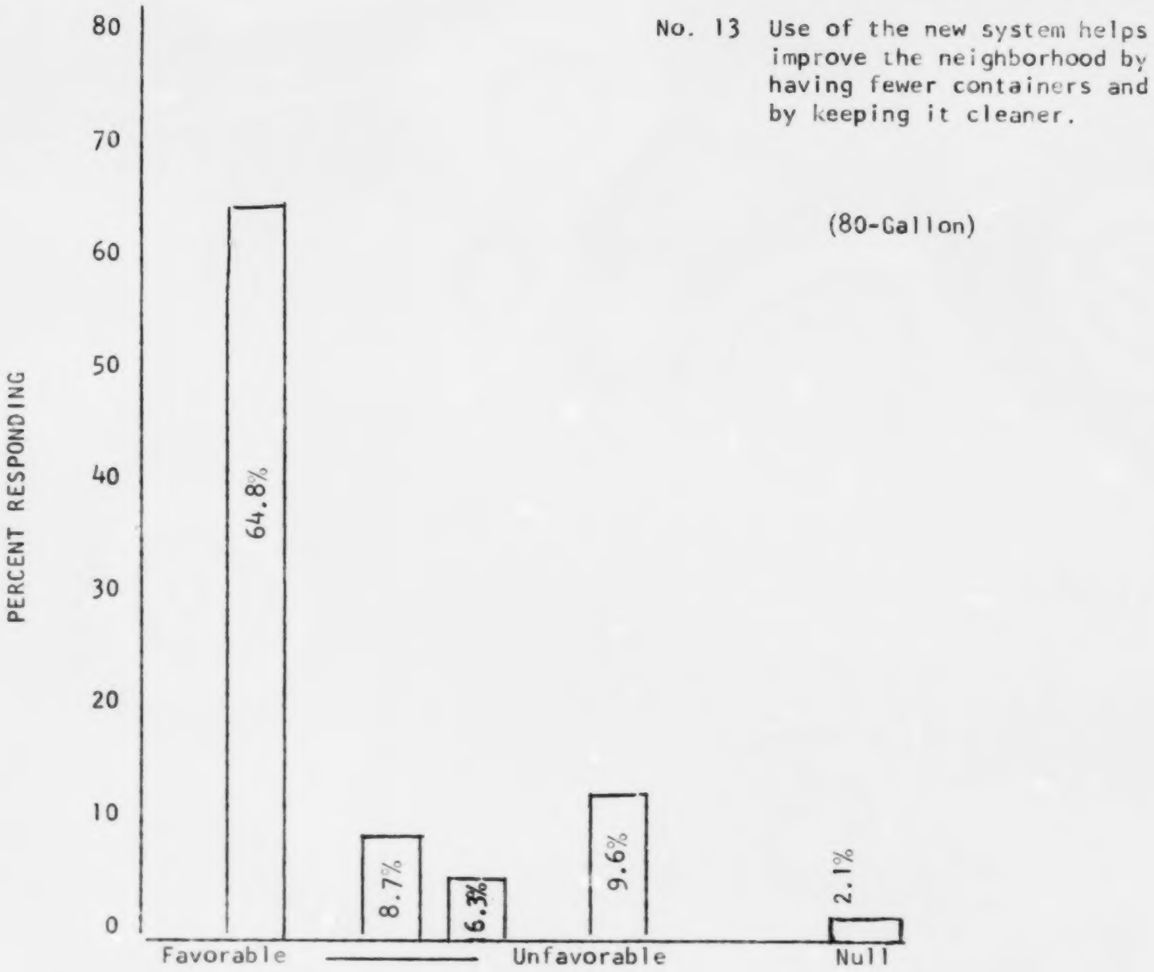


FIGURE G-18. RESPONSE TO THE NEW SYSTEM



No. 13 Use of the new system helps improve the neighborhood by having fewer containers and by keeping it cleaner.

(80-Gallon)

FIGURE G-19. RESPONSE TO THE NEW SYSTEM

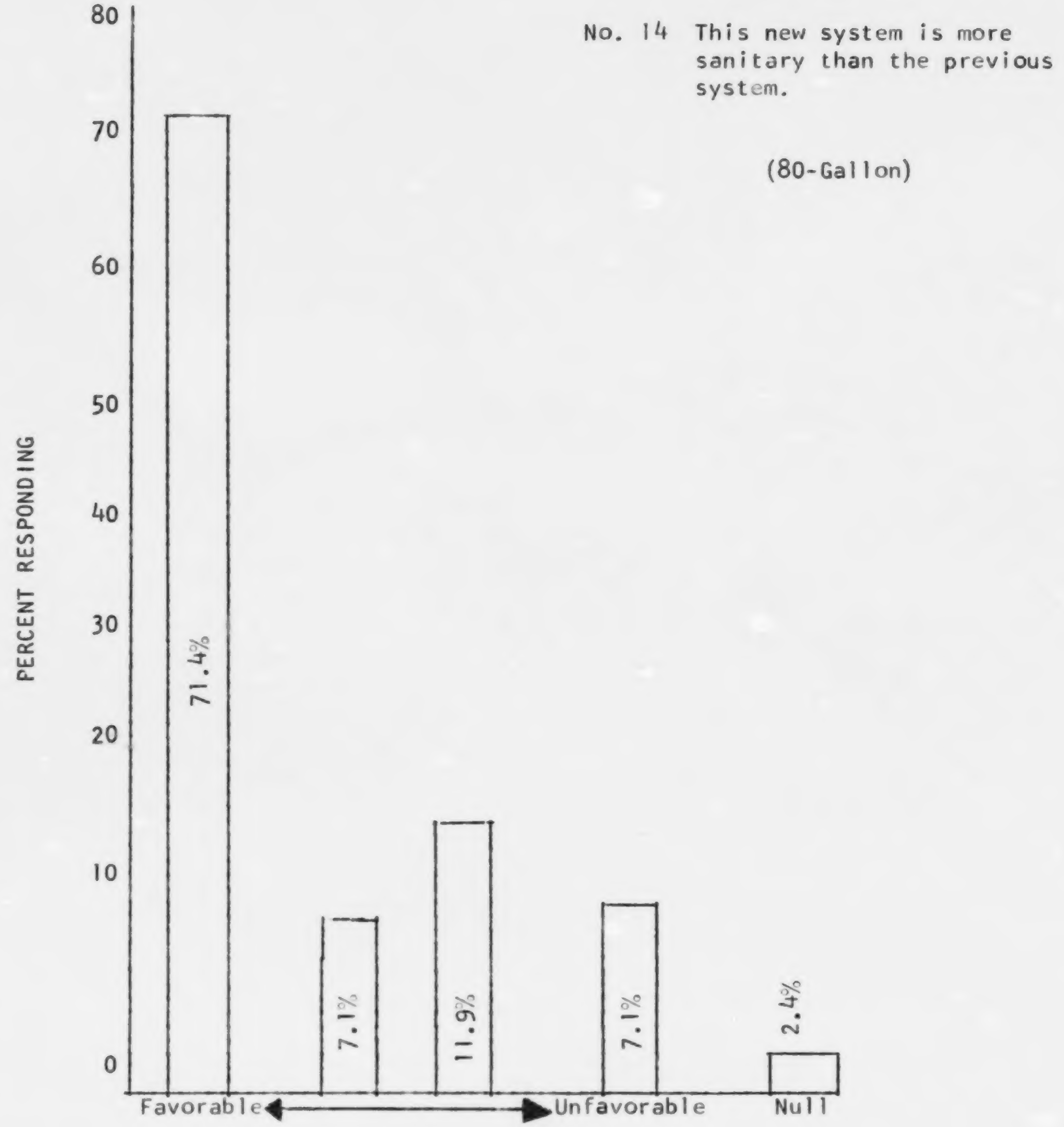


FIGURE G-20. RESPONSE TO THE NEW SYSTEM

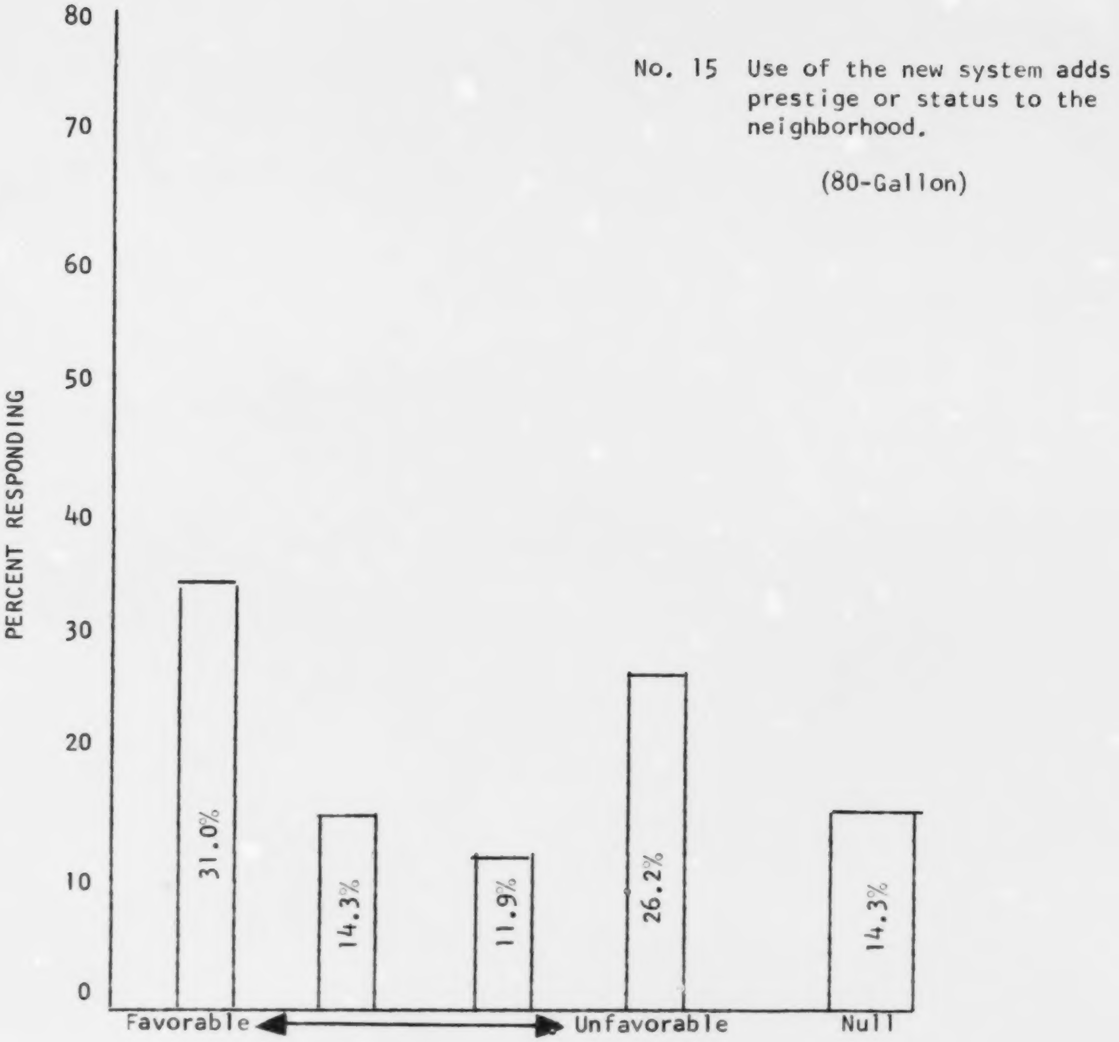


FIGURE G-21. RESPONSE TO THE NEW SYSTEM

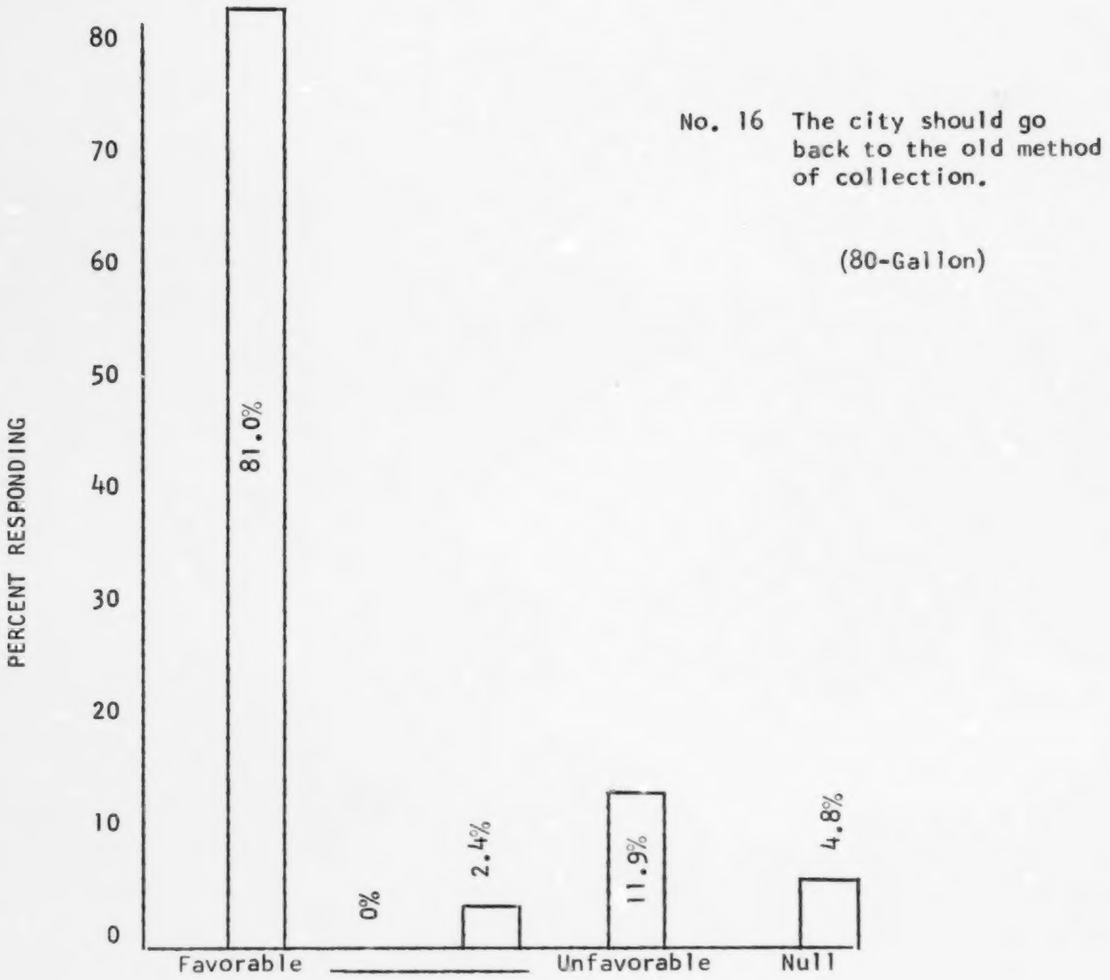


FIGURE G-22. RESPONSE TO THE NEW SYSTEM

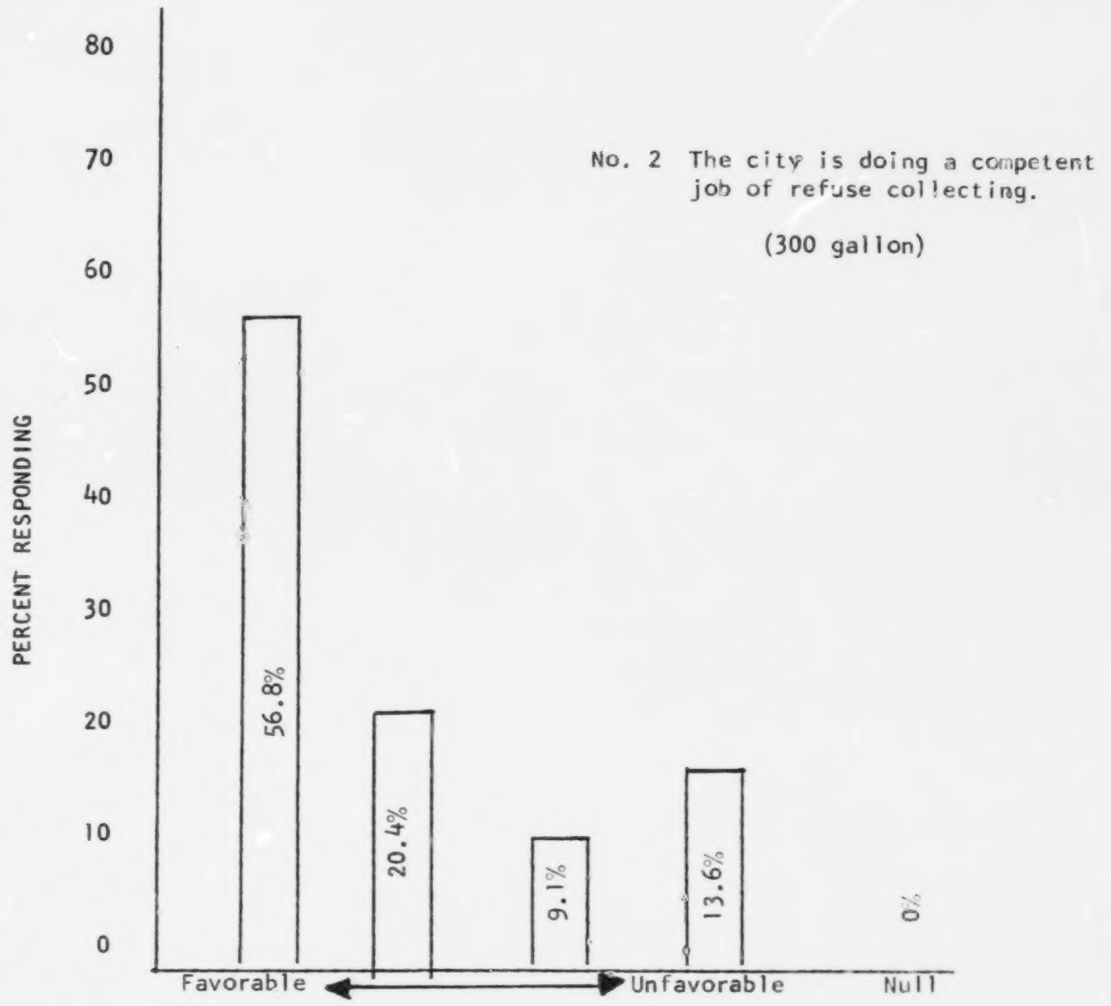


FIGURE G-23. RESPONSE TO THE NEW SYSTEM

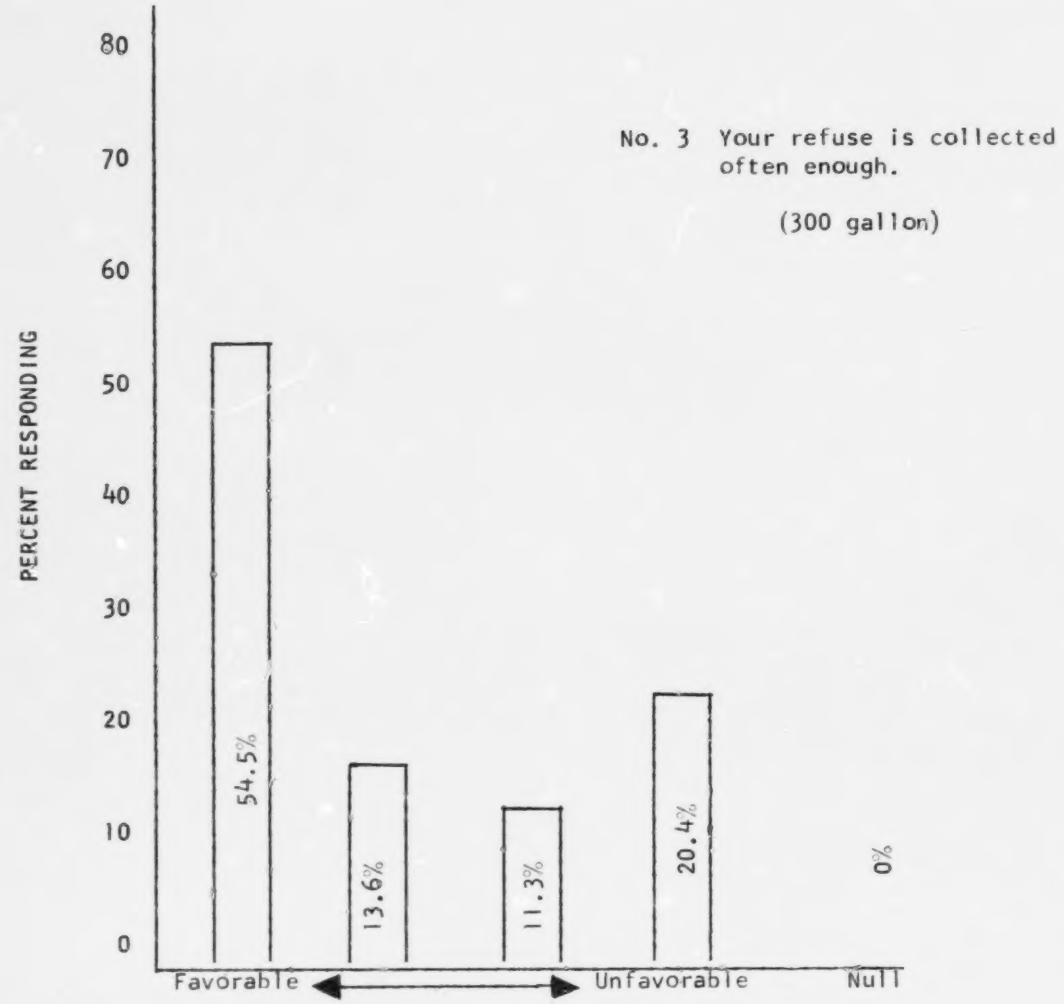


FIGURE G-24. RESPONSE TO THE NEW SYSTEM

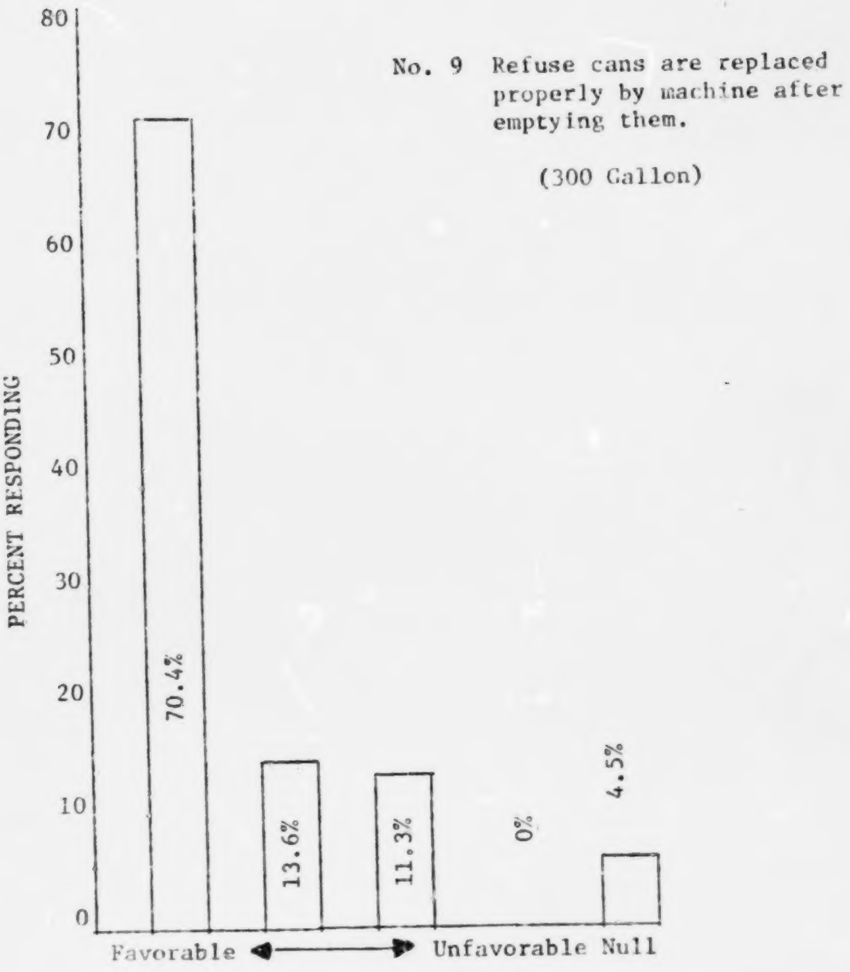


FIGURE G-25. RESPONSE TO THE NEW SYSTEM

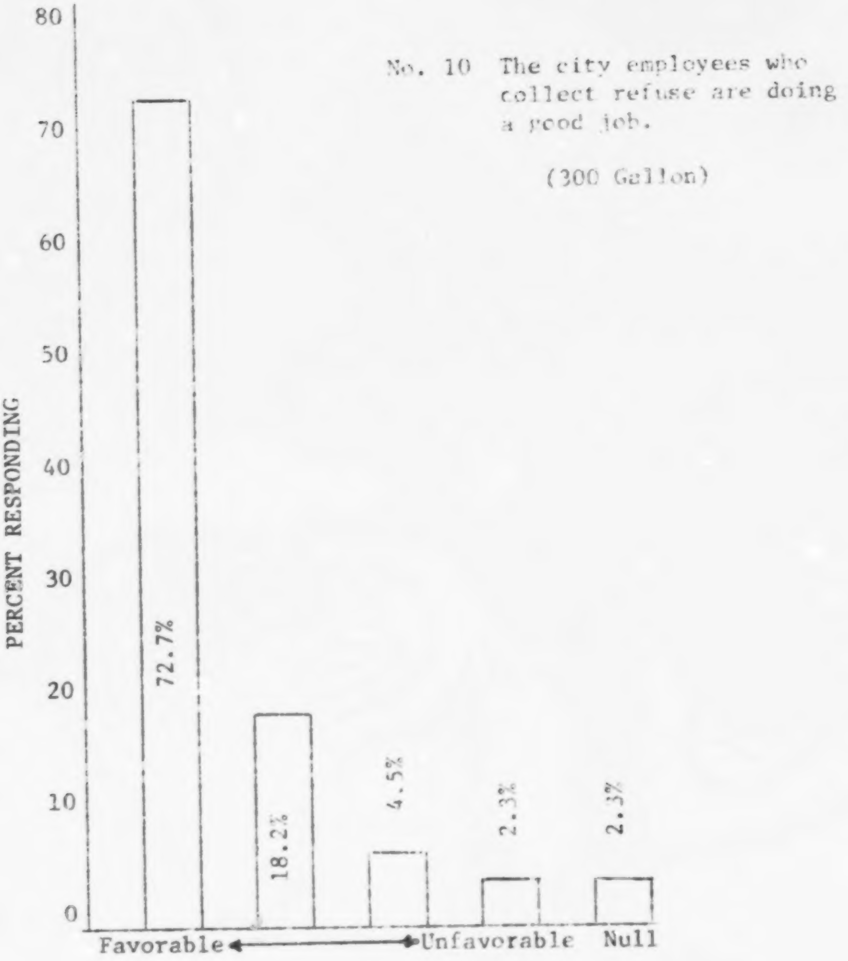


FIGURE G-26. RESPONSE TO THE NEW SYSTEM

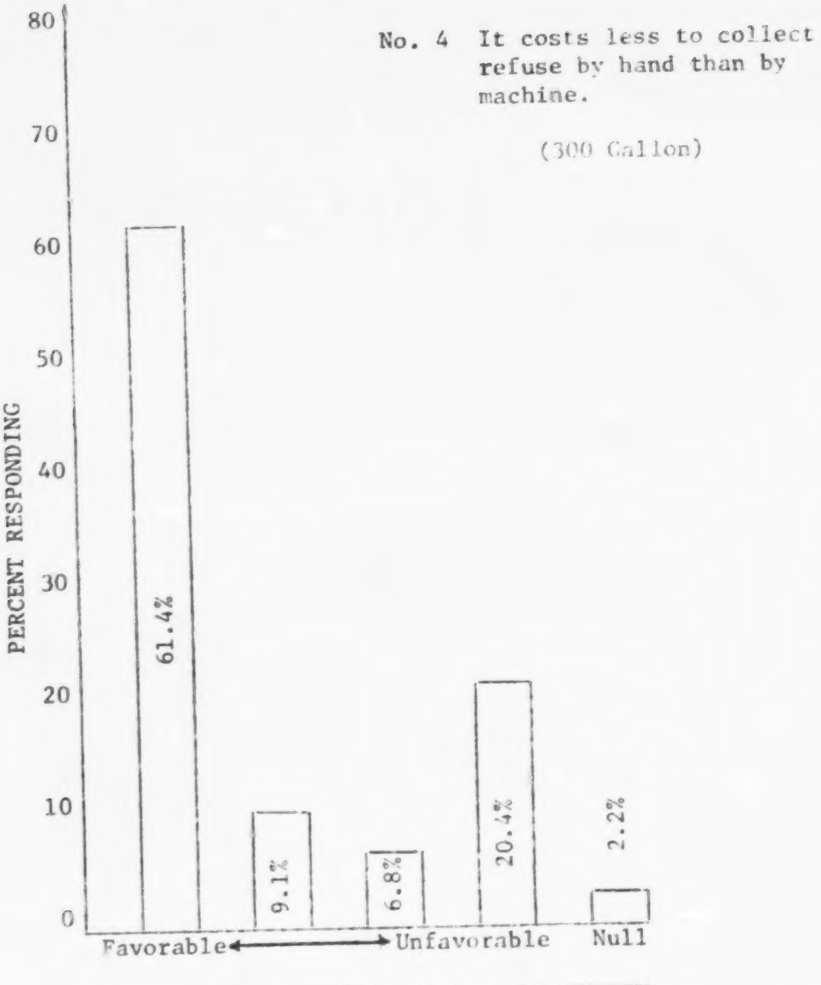
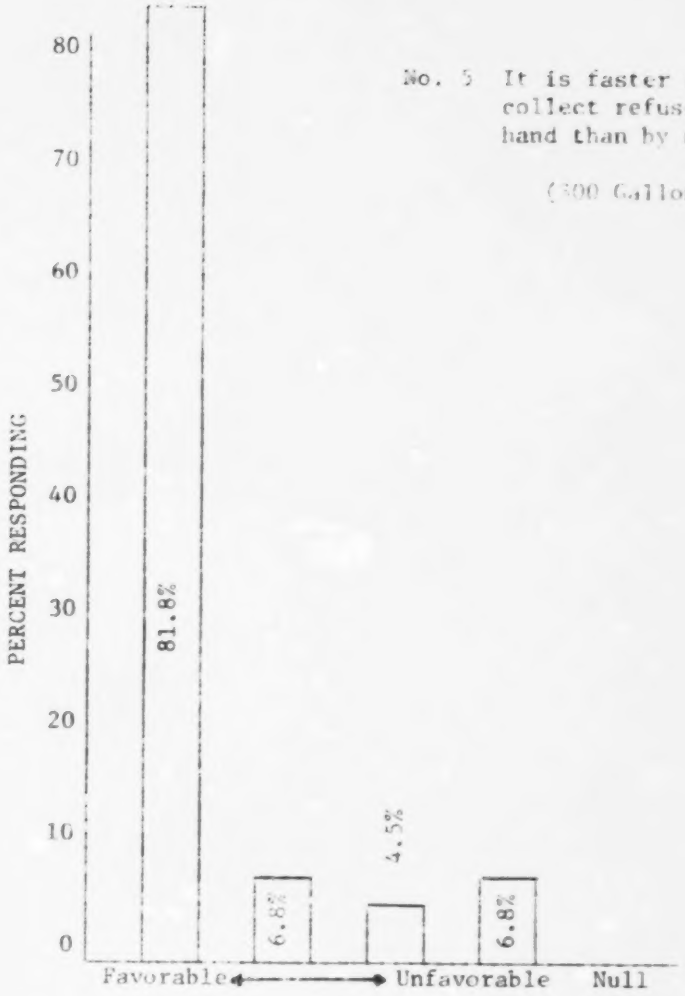


FIGURE G-27. RESPONSE TO THE NEW SYSTEM



No. 5 It is faster to collect refuse by hand than by machine.

(300 Gallon

FIGURE G-28. RESPONSE TO THE NEW SYSTEM

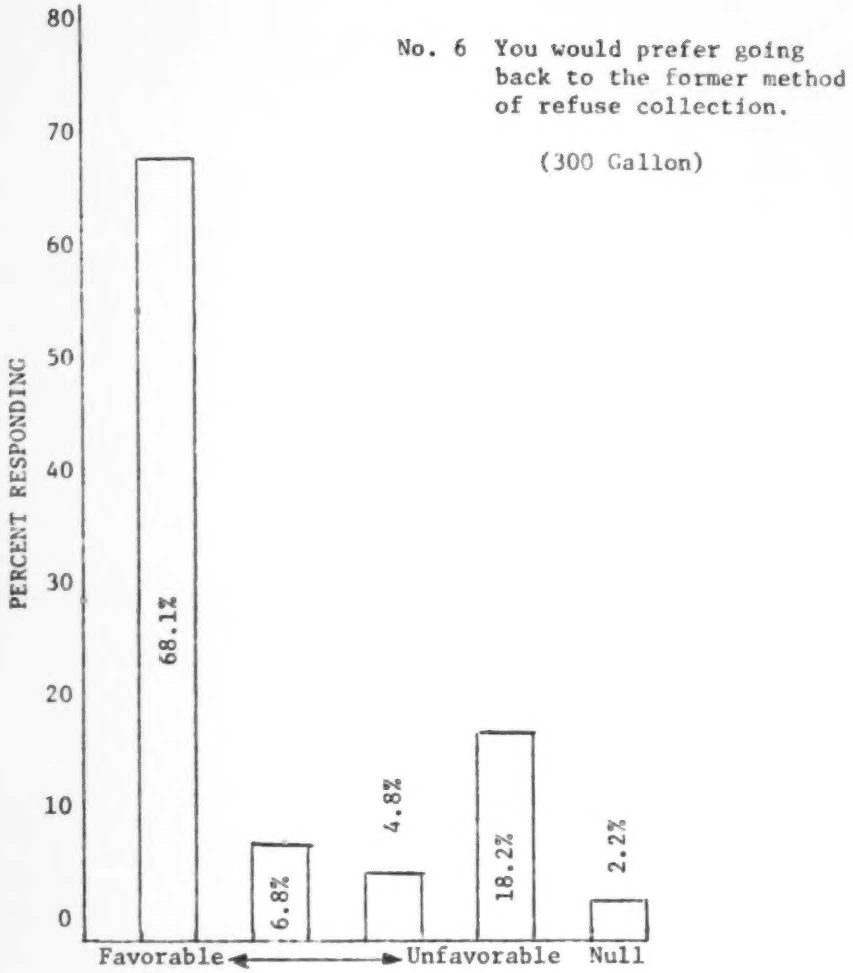


FIGURE G-29. RESPONSE TO THE NEW SYSTEM

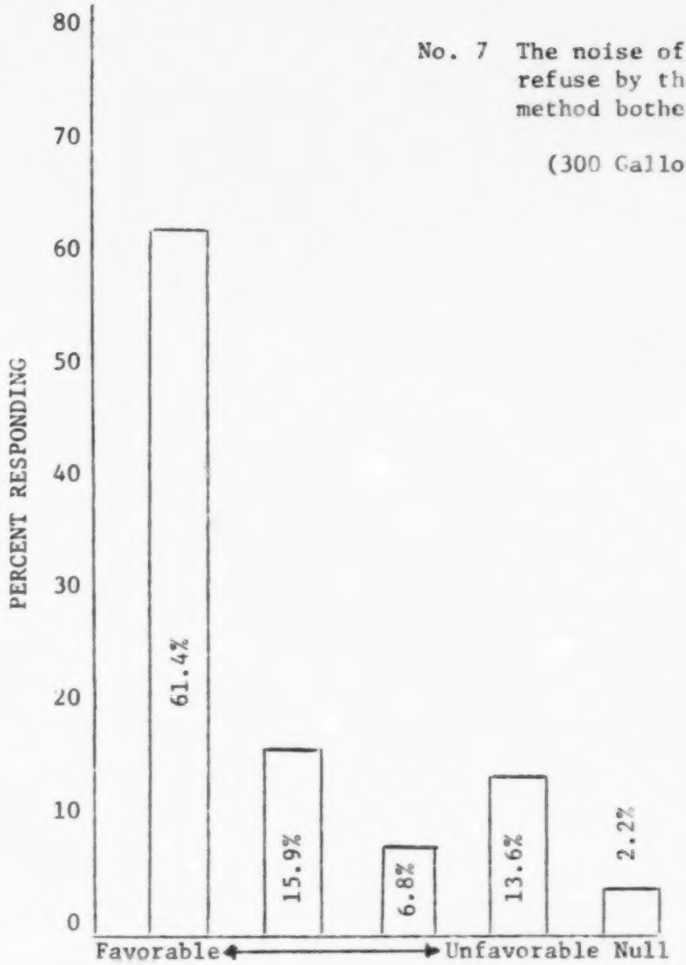


FIGURE G-30. RESPONSE TO THE NEW SYSTEM

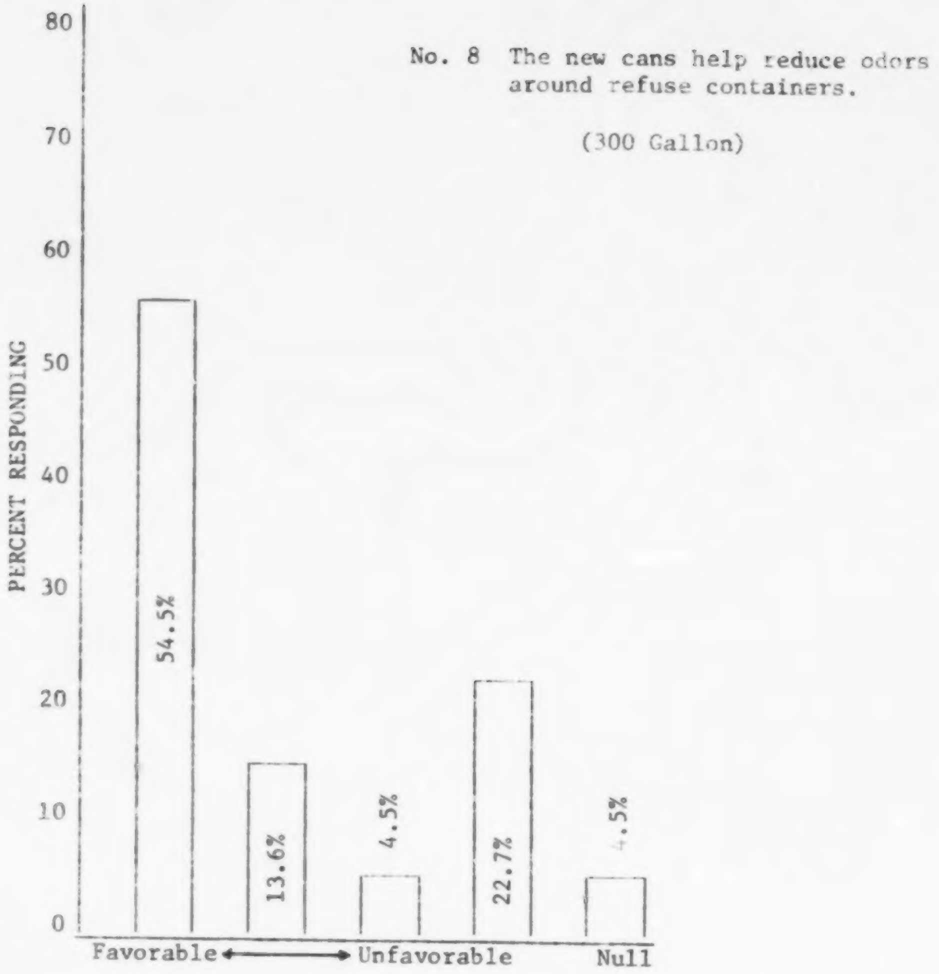


FIGURE G-31. RESPONSE TO THE NEW SYSTEM

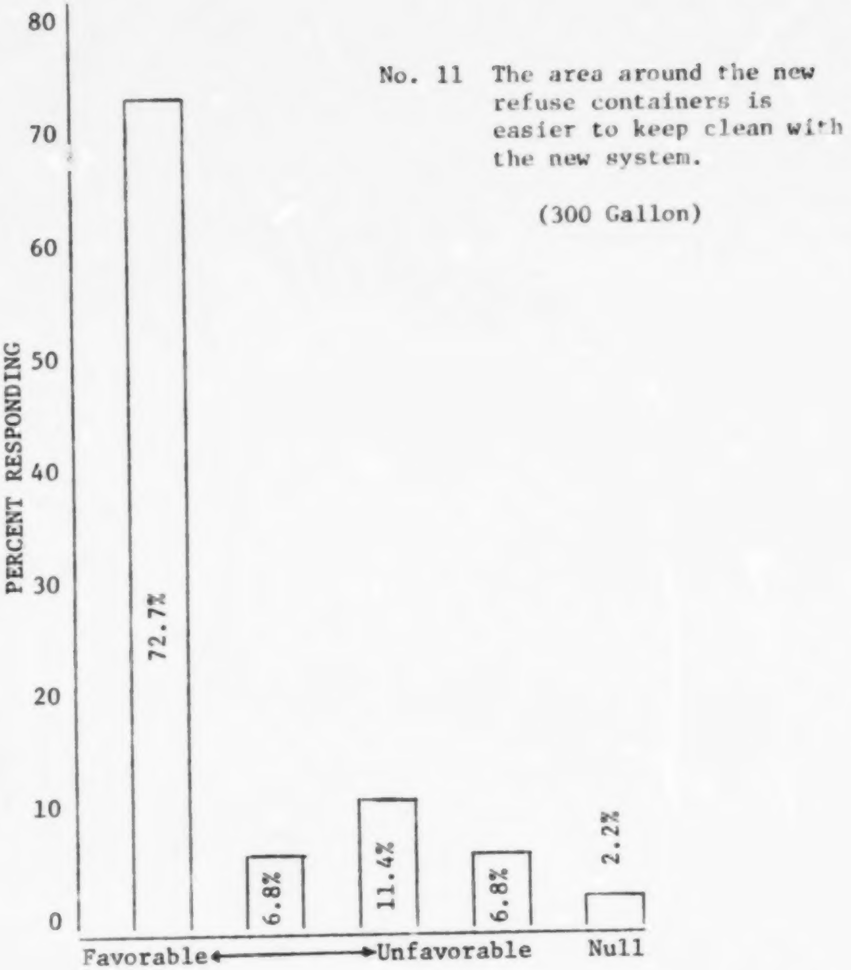


FIGURE G-32. RESPONSE TO THE NEW SYSTEM

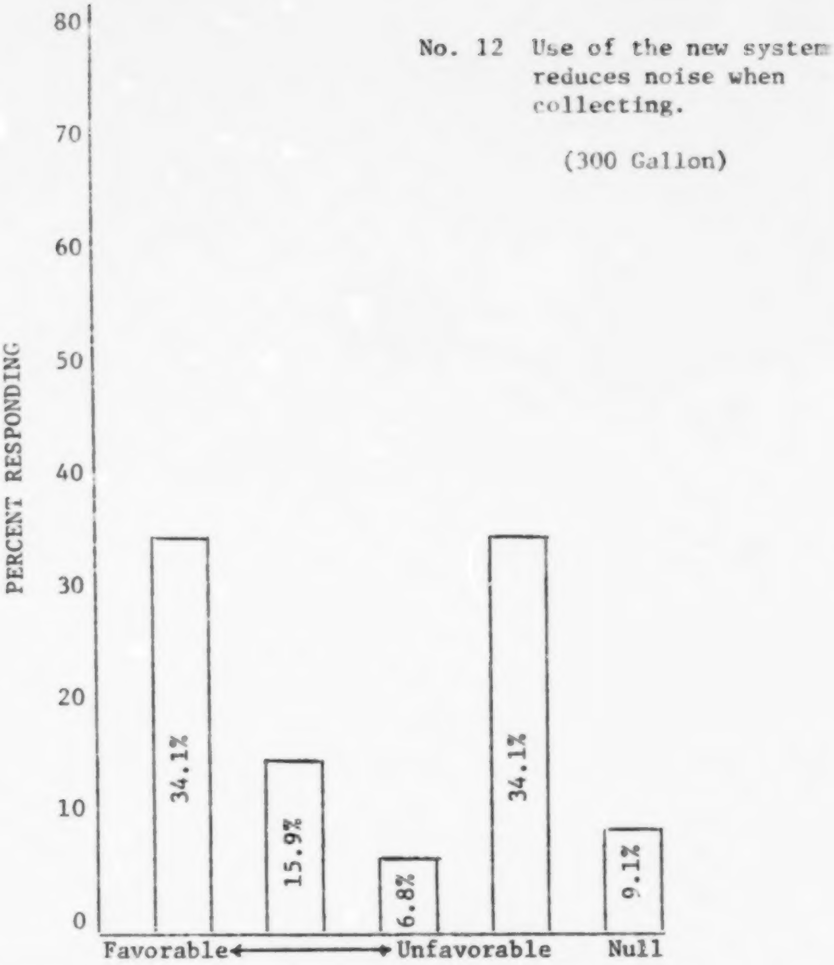


FIGURE G-33. RESPONSE TO THE NEW SYSTEM

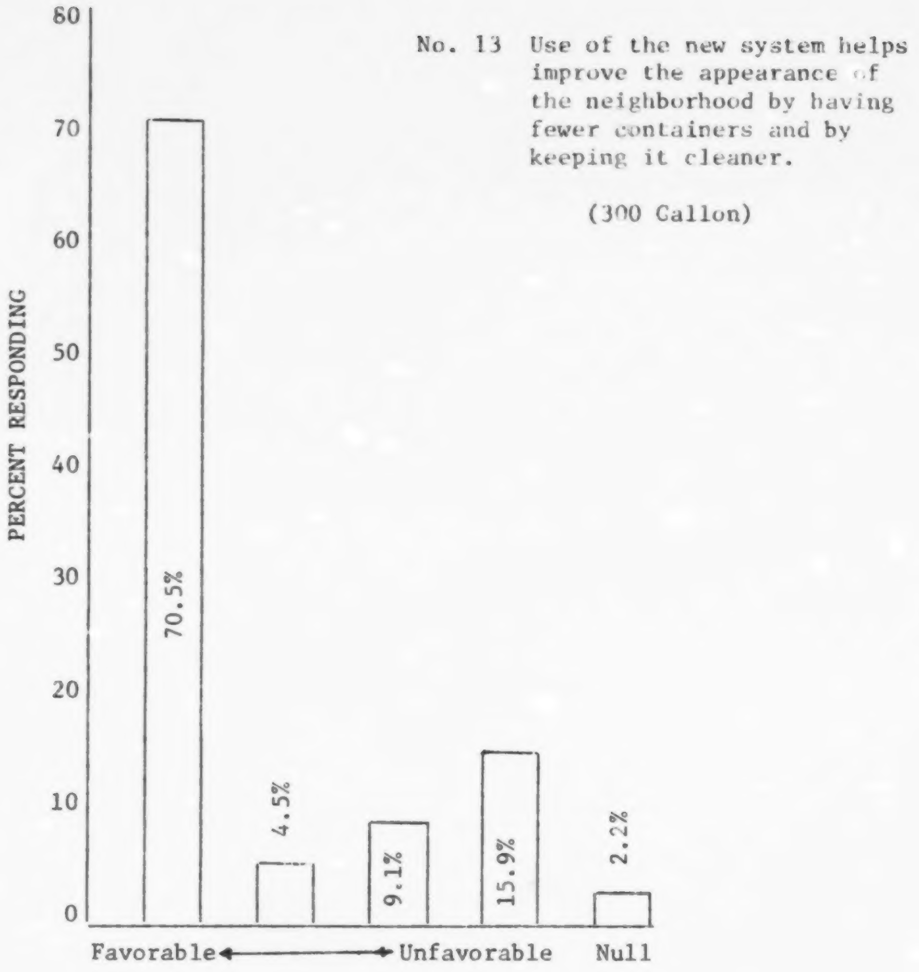


FIGURE G-34. RESPONSE TO THE NEW SYSTEM

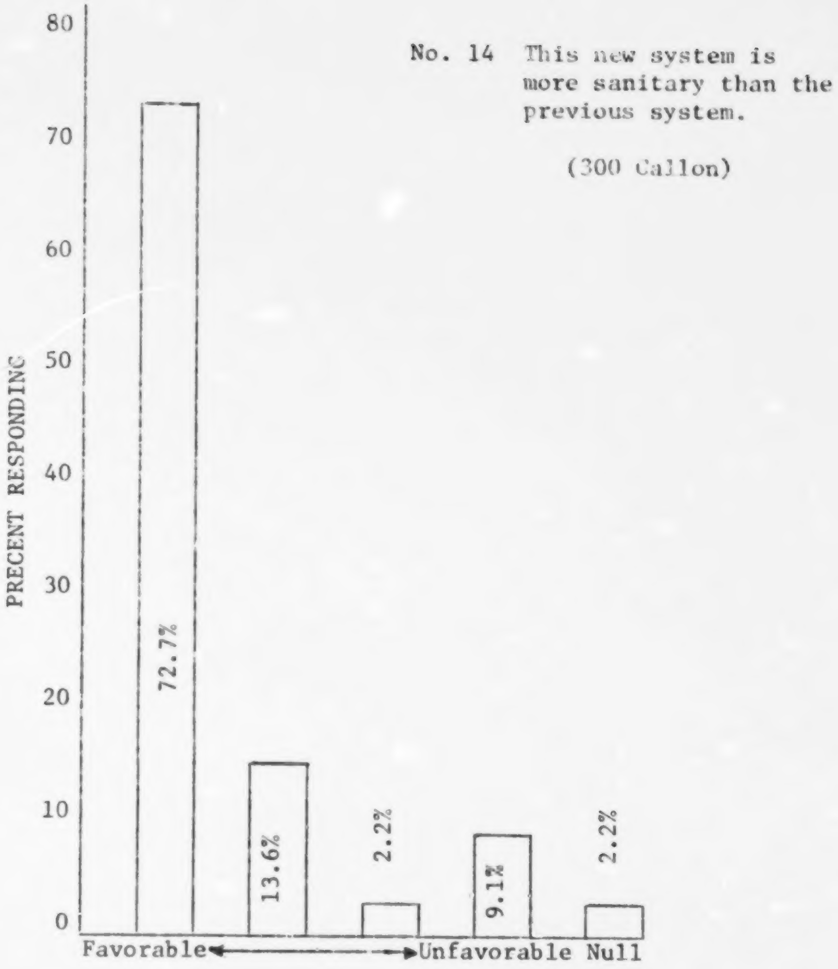


FIGURE G-35. RESPONSE TO THE NEW SYSTEM

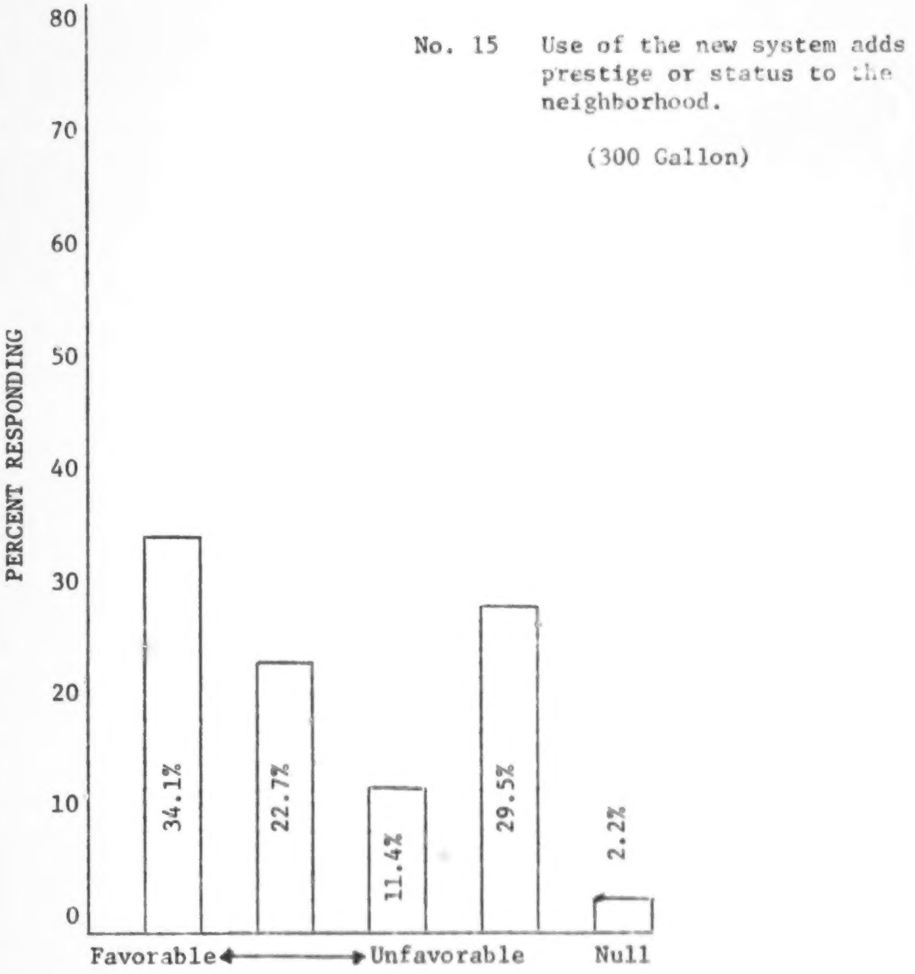


FIGURE G-36. RESPONSE TO THE NEW SYSTEM

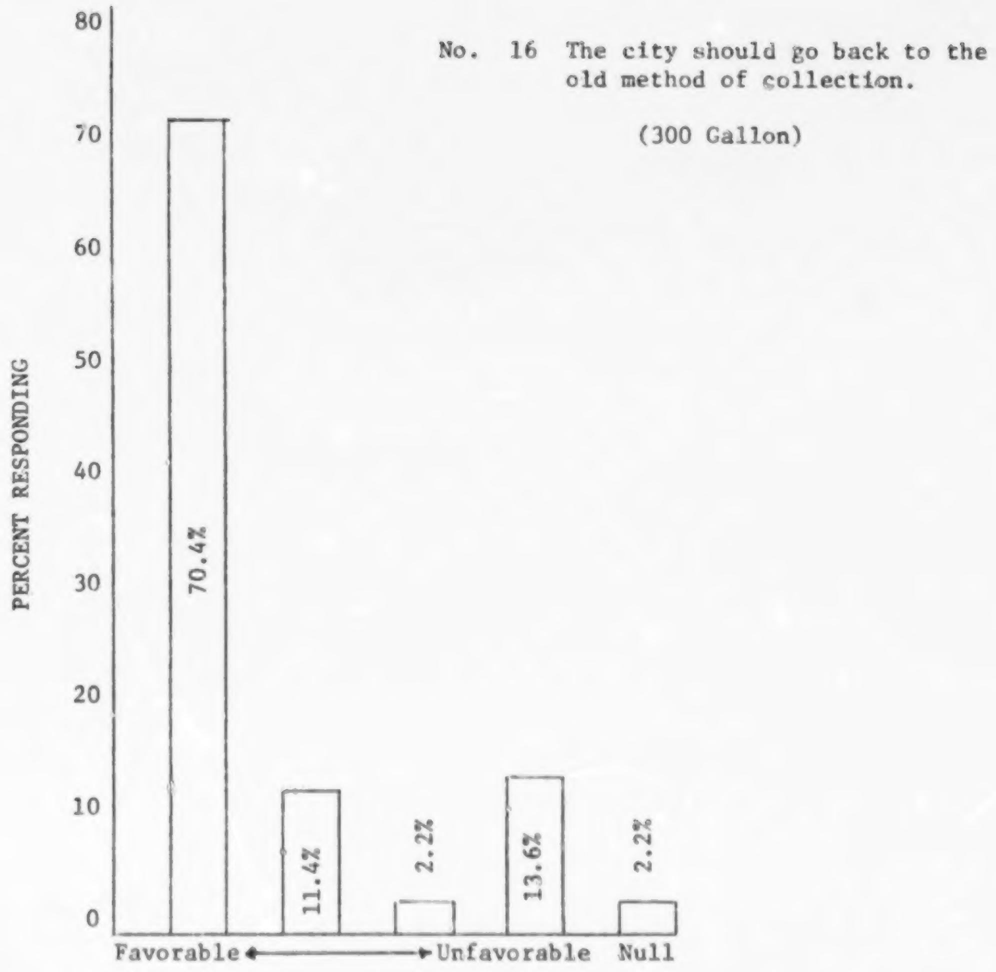


FIGURE G-37. RESPONSE TO THE NEW SYSTEM

APPENDIX H

REFUSE ORDINANCE

ORDINANCE NO. 538

AN ORDINANCE OF THE MAYOR AND COUNCIL OF THE CITY OF SCOTTSDALE, MARICOPA COUNTY, ARIZONA, RELATING TO THE COLLECTION OF GARBAGE, TRASH AND REFUSE: PRESCRIBING CERTAIN DUTIES OF REFUSE GENERATORS: PROVIDING FOR COLLECTION CHARGES: PROVIDING FOR ASSESSING THE COSTS OF SUCH COLLECTION AGAINST THE PROPERTY; PROVIDING FOR MAKING THE ASSESSMENT A LIEN AGAINST THE PROPERTY; PROHIBITING THE DEPOSIT OF SPECIFIED SUBSTANCES; PRESCRIBING UNLAWFUL ACTS; PROVIDING A PENALTY FOR VIOLATIONS; REPEALING SECTIONS 10-1 THROUGH 10-10 OF ARTICLE I OF THE SCOTTSDALE CITY CODE AND ORDINANCES NOS. 116, 263, 278; AND DECLARING AN EMERGENCY.

BE IT ORDAINED BY THE MAYOR AND COUNCIL OF THE CITY OF SCOTTSDALE, ARIZONA, that Article I, of Chapter X of the Code of the City of Scottsdale be, and the same is hereby amended to read as follows:

Section 10-1, Short Title

This Article shall be known and may be cited as the "Refuse Ordinance."

Section 10-2, Definitions

In this Article, unless the context otherwise requires:

1. Assessment means the fee imposed for recovery of garbage collection costs incurred for benefiting particular property of any person which is levied on pursuant to this article.

2. Brush means tree limbs and shrubbery clippings exceeding three feet in length.

3. Bulk rubbish means wooden and cardboard boxes, crates, appliances, large items of household furniture, and other refuse items which by size and shape are not readily containable.

4. Collection employee means any individual employed by the City of Scottsdale for the purpose of effectuating the provisions of this article.

5. Commercial refuse generator means any person in charge of, owning, leasing, renting or occupying any business, industrial or commercial building other than a private residence, including, but not limited to a store, office, factory, hotel, tourist court, motel, motor court, motor hotel, trailer court, apartment hotel or residential building ordinarily leased for a period of less than three (3) months.

6. Construction waste means material from construction, remodeling, construction site preparation, including, but not limited to rocks, trees, debris, dirt, brick, fill, plaster, and all types of scrap building materials.

7. Containable rubbish means all putrescible and non-putrescible solid wastes including, but not limited to wrapped garbage, wrapped small dead animals, wrapped or boxed ashes, wastepaper, excelsior, rags, bottles, crockery, bedding, clothing, carpets, leather, tin cans, metal scraps, small mechanical parts, shavings, floor sweepings, grass and weed clippings, twigs, tree limbs not exceeding three feel in length and other similar waste or debris.

8. Filth means manure, excrement, or similar substance.

9. Garbage is putrescible and vegetable wastes resulting from the handling, preparation, cooking and consumption of food.

10. Lien means a charge which attaches in favor of the City to real property benefited by the collection of any brush, trash, bulk rubbish, containable rubbish, filth, construction waste, or refuse; said lien also attaches to any other real or personal property of a person or any refuse generator, owning or in charge of benefited property, to secure the payment of unpaid monthly collection costs as hereinafter described.

11. Open area means any park, street, gutter, sidewalk, sewer, boulevard, alley, greenbelt, square, vacant lot, space, ground or other area where refuse material may accumulate.

12. Person means any individual, firm, partnership, corporation, institution or other entity acting as principal, agent, officer, servant or employee for himself or itself, or for any other individual, firm, partnership, corporation, institution or other entity, who owns, leases, rents or occupies any real property within the city limits.

13. Prohibited substance means any liquid, solid, or gas with an ignition temperature or flash point of less than 200° F, including but not limited to gasoline, benzine, naptha, or other flammable or explosives; any material having a pH lower than five and one-half (5½) or higher than nine (9) or having any other corrosive property that could be injurious or hazardous to city collection employees or which could cause damage to equipment; any noxious or malodorous substance offensive to the senses and depriving a neighborhood or a considerable number of persons of the comfortable enjoyment of life or property; or any hypodermic needle or syringe.

14. Refuse means all putrescible and non-putrescible solid wastes (except body wastes), including garbage, rubbish, ashes, street cleanings, dead animals; abandoned, wrecked or junked vehicles or parts thereof; brush, and containable rubbish, filth, construction waste and prohibited substances when these terms are not specifically noted in this article.

15. Residential refuse generator means any person in charge of, owning, leasing, renting or occupying any building or buildings used solely for a family or private residential domicile, including, but not limited to single and multiple family dwelling units, apartments, townhouses, cooperatives, condominiums, board and rooming houses.

16. Superintendent of Sanitation means the head of the Department of Sanitation or his duly authorized agent.

17. Trash means rubbish, waste, debris or refuse.

18. Vicious animal means any animal of a vicious species or an animal of a domesticated species, including but not limited to cats and dogs, which without provocation is prone to attack persons.

Section 10-3. Authority to collect refuse; unauthorized hauling; permit.

A. The City of Scottsdale, its duly authorized agents, servants, or employees, have the exclusive right to collect refuse within the city without limitation to the city's authorization of collectors by license, franchise, permit or contract.

B. Persons not hauling for hire may be issued a permit to deposit a maximum of one and one-half ($1\frac{1}{2}$) cubic yards of refuse per day in the City-designated disposal area.

Section 10-4. Refuse to be placed in receptacles or containers; specifications.

A. It shall be the duty of every person, commercial or residential refuse generator to place or cause to be placed all refuse accumulating on the premises in suitable receptacles or containers provided by such person or by the City.

B. All refuse containers shall be waterproof and equipped with tight-fitting covers resistant to disburbance by animals and insects. Plastic bags or other containers approved by the Superintendent of Sanitation may be used.

Section 10-5, Residential refuse generators, collection procedures; Private and City-owned containers.

A. Bulk rubbish and brush shall be placed next to containable rubbish located in the manner hereinafter prescribed in Paragraph D of this section. No more than ten (10) loose yards of brush shall be collected from a single residence on a scheduled brush collection. Century plants, cacti, and similar plants hazardous to collection employees shall be contained in lengths of less than three (3) feet.

B. The Superintendent of Sanitation may require any residential generator regularly exceeding eighty gallons (80) or one-hundred twenty (120) pounds of refuse within a collection period, or any resident regularly generating refuse requiring special handling, to use a commercial disposal system or to make other approved disposal arrangements.

C. Residential refuse generators, not equipped with City-owned containers, shall place containable rubbish in cardboard boxes, refuse cans or other approved containers having a gross weight not exceeding sixty (60) pounds, suitable for handling by two (2) collection employees.

D. Residential refuse generators shall place refuse containers on the scheduled collection days in the alley located at the rear or side of their property or if there is no alley, at the curbline in front of the residence. Containers shall not be placed for collection at said curbline before six o'clock P.M. on the day preceding the day of collection and after such containers are emptied, they shall be removed from the curbline by six o'clock P.M. on the day of collection.

E. City-owned containers shall be distributed and positioned as scheduled by the Superintendent of Sanitation. Containers serving more than one residence shall be positioned along rear or side alleys not more than one-hundred (100) feet from the property line of any residence so serviced. If there are no alleys, individual portable containers may be supplied by the City.

F. Residential refuse generators equipped with City-owned containers shall first place, or cause to be placed, in such containers all garbage followed by other containable rubbish.

G. To insure optimal use of the City-owned containers and the ancillary equipment used therewith, the contents of the individual containers shall not exceed five hundred (500) pounds weight limit.

H. Each residential refuse generator is responsible for the maintenance of sanitary containers.

Section 10-6, Commercial refuse generators; duties generally; use of City-owned containers.

A. All commercial refuse generators shall maintain their alleys and the area surrounding the refuse containers free from refuse and other potential hazards to the public health, safety, or welfare. Where unusual or inordinate waste material is generated, special collections shall be arranged therefor with the City.

B. Commercial establishments may, by contract receive City refuse collection services and City-owned containers. These containers shall be positioned by the City no more than three-hundred (300) feet from an entrance to the commercial structure as designated by the commercial refuse generator; provided, however, that collection employees shall at all times have convenient accessibility to said containers.

Section 10-7, Prohibited substances; method of collection; exception.

A. No person shall deposit or cause to be deposited in any refuse container which is serviced by the City any prohibited substance as defined in Section 10-1 (13). All prohibited substances shall be separated from containers used for regular collections and placed in special containers and the contents thereof shall be clearly labeled.

B. Every refuse generator shall call the Superintendent of Sanitation for special collection of these items; provided, however, that this section shall not apply to any refuse generator who has secured the prior written approval of the Superintendent of Sanitation for otherwise disposing of prohibited substances.

Section 10-8. Collection rates; uniformity; time for payment; penalty.

A. Periodically the City Council by resolution published and posted, shall establish appropriate rates for the various categories of refuse collection service.

B. The rates charged for collection service shall be uniform for the various classes of users; discrimination as to rates is hereby prohibited.

C. All charges shall become due and payable at such time as shall be established by resolution of the City Council, and if such charges are not paid within twenty (20) days when the same shall become due and payable, a penalty of ten (10) percent shall be added thereto.

Section 10-8.1. Collection charges personal debt; civil suit for payment; cumulative remedy.

Every charge, rental or collection fee levied by or pursuant to Section 10-8 shall become, from and after the time it is due and payable, a personal debt of the person, commercial or residential refuse generator, receiving collection service, and may be collected by civil suit instituted in the name of the City, by its City Attorney, upon the request of the City Manager at any time after the penalty as provided in Section 10-8 (C) attaches to the aforesaid charges, rentals or fees. Notwithstanding any other provision to the contrary, the remedy provided by this section shall cumulate and supplement other remedies provided under this article.

Section 10-8.2. Right to lien for collection charges; notice and claim of lien; contents; form; perfection; duration; release.

A. A right to a lien shall arise immediately upon the providing of collection service. If said charge, rental or collection fee is not paid thirty (30) days after it has become due and payable, the City may issue a notice and claim of lien setting forth the following information:

1. Name of the person, commercial or residential generator owing said charge, rental or collection fee;
2. The amount owned;
3. The penalty accrued to date;
4. The calendar period (s) for which said charges, rentals or collection fees are due and owing;
5. A statement that the City claims a lien therefor.

B. The notice and claim of lien shall be issued under the official seal of the City, signed by the Mayor and recorded in the office of the County Recorder of Maricopa County, Arizona. The amount stated in said lien shall be a lien upon all real and personal property of the person, commercial or residential refuse generator, located in Maricopa County. Such lien shall be subject and inferior to the lien for general taxes and to all prior recorded mortgages and encumbrances of record.

C. A lien claimed under this section shall not continue for more than three (3) years after it has been recorded, unless an action is brought within such period to enforce the lien.

D. Any lien claimed pursuant to this section shall, upon payment of the entire amount due, be released by the City in the same manner as mortgages and judgments are released.

E. A prior lien, recorded for the purposes of this section, shall not constitute a bar to the recordation of a subsequent lien or liens for such purposes.

Section 10-9. Unlawful Acts.

It is unlawful for any person to:

1. Place or cause to be placed any refuse upon any public or private property not owned or under his control;

2. Place or cause to be placed any unwrapped putrescible waste in any refuse container, unless all liquid shall have been drained therefrom;

3. Place or cause to be placed more than a limited amount of filth in a refuse container; limits to be set by the Superintendent of Sanitation or his agent;

4. Place or cause to be placed any unwrapped filth in any refuse container, unless the container is used only for that purpose;

5. Place or cause to be placed any unwrapped, small, dead animal in a refuse container.

6. Fail to make arrangements for the removal of construction waste within thirty (30) days after it is generated, but in no case before:

   a. Final building inspection;

   b. Clearance of public utilities;

   c. Issuance of a certificate of occupancy.

7. Place or cause to be placed refuse in a container not owned or maintained by him;

8. Burn or cause to be burned any refuse without the written permission of the Superintendent of Sanitation and the Fire Marshal;

9. Permit or cause, wilfully or negligently, the escape or flow of water in such quantity as to result in flooding, and impeding of vehicular or pedestrian traffic, thereby causing damage to public rights-of-way, private premises not owned by said person responsible for such generation, and creating a hazard to such traffic and a threat to the public health, safety and welfare.

10. Fail to restrain any vicious animal and prevent interference with collection employees acting in the course of their employment;

11. Close or obstruct any right-of-way, impeding the normal operations of the Division of Sanitation, Public Works Department, Fire Department, or the Police Department, unless a special permit has been granted by the Superintendent of Sanitation, Superintendent of Streets, Fire Chief or Chief of Police, at least three (3) days prior to closing the right-of-way.

12. Close or obstruct an alley for more than twenty-four (24) consecutive hours, unless such closing is for the purpose of making sewer, gas or water utility installations;

13. Remove, haul or cause to be removed any refuse, on or along any City right-of-way, street or alley, unless the same is contained in water-tight containers so constructed as to prevent any such refuse from falling, leaking or spilling therefrom.

Section 10-9.1, Duty to enforce article.

It is the duty of the Superintendent of Sanitation or his authorized representative to enforce the terms of this article.

Section 10-10, Penalties.

A. Violation of any provision of this ordinance shall be deemed a misdemeanor, and a violator upon conviction thereof, shall be fined in an amount not exceeding three hundred dollars ($300.00) or be imprisoned for a period not exceeding thirty (30) days or be both fined and imprisoned.

B. Each day such violation is committed or permitted to continue shall constitute an offense and shall be punishable as such hereunder.

ORDINANCE NO. 579

AN ORDINANCE OF THE MAYOR AND COUNCIL OF THE CITY OF SCOTTSDALE, MARICOPA COUNTY, ARIZONA, AMENDING ORDINANCE NO. 538, THE REFUSE ORDINANCE, BY ADDING A NEW SECTION, NUMBER 10-4.1, RELATING TO REFUSE CONTAINERS; AND DECLARING AN EMERGENCY.

BE IT ORDAINED by the Mayor and Council of the City of Scottsdale, Arizona, as follows:

The Scottsdale City Zoning Ordinance Number 538, the refuse ordinance, is amended by adding Section 10-4.1, as follows:

SECTION 10-4.1 - It shall be the duty of the owner or developer of all new construction and development within the City of Scottsdale, when such development is not subject to the provisions of the Scottsdale Subdivision Ordinance No. 540 with respect to refuse containers, to supply at his expense refuse containers which shall become the property of the City. The type of such containers shall be approved by the City Engineer.

ORDINANCE NO. 580

AN ORDINANCE OF THE MAYOR AND COUNCIL OF THE CITY OF SCOTTSDALE, MARICOPA COUNTY, ARIZONA, AMENDING ORDINANCE NO. 540, SECTION 404.14, RELATING TO SUBDIVISIONS; AND DECLARING AN EMERGENCY.

BE IT ORDAINED by the Mayor and Council of the City of Scottsdale, Arizona, as follows:

The Scottsdale City Zoning Ordinance Number 540, the Subdivision Ordinance, Section 404.14, is amended to read as follows:

SECTION 404.14 - Refuse Containers: Each lot or combination of lots shall be supplied with a refuse container, at the expense of the developer or subdivider, to be owned by the City, as approved by the City Engineer.